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# **Prompting improved public health behaviours through the application of behavioural insights to message design.**

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Thesis submitted in fulfilment of the requirements for the  
degree of Doctor of Philosophy in Psychology  
by Published Work.

University of Warwick, Department of Psychology

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## Abbreviations

APEASE criteria: Assessment criteria for intervention practicability: Acceptability, Practicability, Effectiveness, Affordability, Side-effects, and Equity

BCT-T V1: Behaviour Change Technique Taxonomy Version 1

BCT: Behaviour Change Technique

BCW: Behaviour Change Wheel

BI: Behavioural Insights

COM-B: Capability, Opportunity, Motivation – Behaviour Model

DNA: Did Not Attend

HP: Health Psychology

IF: Intervention Function

NCMP: National Child Measurement Programme

NHS: National Health Service

NHSBT: National Health Service Blood & Transplant

NHS HC: National Health Service Health Check

ODR: Organ Donation Register

OW: Overweight

RCT: Randomised Controlled Trial

SMS: Short Message Service

TaTT: Theory and Techniques Tool

TDF: Theoretical Domains Framework

VOW: Very overweight

WMS: Weight Management Service

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Thank you to my husband Paul and daughter Emily for being super.

This thesis is dedicated to my late father Phil Sallis who would actually have read it!

## PhD by Published Work declaration

I declare that the submitted material is not substantially the same as published or unpublished material that have been previously submitted, or are currently in the process of being submitted, for a degree, diploma, or similar qualification at any university or similar institution. Explicitly, none of the submitted material, or the published work, has previously been submitted for any such qualification.

I, Anna Shrapnell (Sallis), declare that where I am not the lead author, the lead author has signed a written statement on the extent of my individual contribution to the study (Studies 6 & 7). For papers where I am the lead author, a statement of contributions is provided detailing all authors contributions. For studies 1, 4, 5 and 8 these statements are taken directly from the published articles and were agreed by all authors at the time of article publication. For studies 2 & 3 a consensus was obtained and signed specifically for this thesis.

**Author signature:**

**Date: 05.08.20**

A solid black rectangular box used to redact the author's signature.

## Author contributions

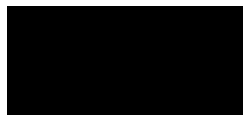
**Study 1:** \*Sallis, A., \*Harper, H., & Sanders, M. (2018). Effect of persuasive messages on National Health Service Organ Donor Registrations: a pragmatic quasi-randomised controlled trial with one million UK road taxpayers. *Trials*, 19(1), 513. doi: 10.1186/s13063-018-2855-5. (\*Joint first authors).

AS drafted the manuscript, researched and drafted the intervention messages and contributed significantly to project management, selection of statistical tests and interpretation of data. HH conceived the study and study design, managed the project with AS, contributed to drafting the intervention messages, made critical revisions to the paper and interpreted the findings. MS planned and executed the research design, analysis and interpretation and made critical revisions to the manuscript. All authors read and approved the final manuscript.

**Study 2:** Sallis, A., Attwood, S., Harper, H., Larsen, J., Berry, D., Vlaev, I., Sanders, M. & Chadborn, T. (2019). A randomised trial of the effect of appearance versus health-framed messages on engagement with an online brief screening and alcohol reduction intervention. *Psychology & Health*, 34(8), 922-942. doi.org/10.1080/08870446.2019.1579911

AS was project lead. DB and AS conceived the study. AS researched the interventions and designed the interventions together with SA and unauthored colleagues at Drinkaware. AS, HH, SA, TC and MS designed the study methodology. HH and AS executed the study with unauthored Drinkaware colleagues. MS and HH selected statistical tests and MS conducted the data analysis. All authors contributed to interpretation of data. AS and SA drafted the manuscript. All authors read and approved the final manuscript.

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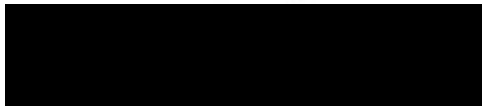
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Hugo Harper:



Date: 20/7/20

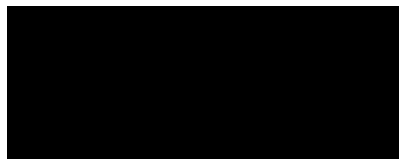
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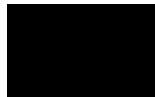
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Dan Berry



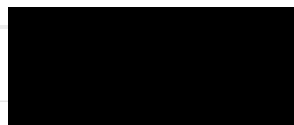
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Michael Sanders



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2020



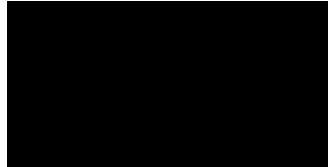
Date: 23 July

**Study 3:** Sallis, A., Porter, L., Tan, K., Howard, R., Brown, L., Jones, A., Ells, L., Adamson, A., Taylor, R., Vlaev, I. & Chadborn, T. (2019) Improving child weight management uptake through enhanced National Child Measurement Programme parental feedback letters: A randomised controlled trial. *Preventive Medicine*, 121, 128-135. doi.org/10.1016/j.ypmed.2019.01.023

AS was project lead. AS, RT, RH and TC conceived the study. AS, RT, RH, IV, AJ, LE, TC and AA designed the interventions. AS, TC, RH, LE, AJ and AA designed the

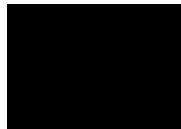
study methodology. AS and RH executed the study. LB, LP, KT and TC planned and conducted the data analysis with input from AS. All authors contributed to interpretation of the data and read and approved the final manuscript. AS prepared the first draft of the paper. LP made critical revisions to the paper. TC supervised the project.

Lucy Porter:



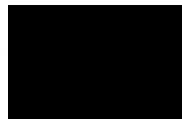
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Karen Tan



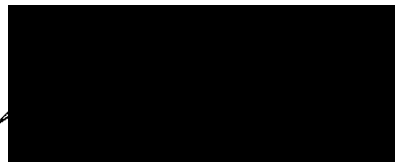
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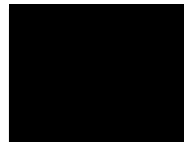
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**Study 4:** Sallis, A., Bunten, A., Bonus, A., James, A., Chadborn, T., & Berry, D. (2016). The effectiveness of an enhanced invitation letter on uptake of National Health Service Health Checks in primary care: a pragmatic quasi-randomised controlled trial. *BMC Family Practice*, 17(1), 35. doi: 10.1186/s12875-016-0426-y.

AS designed the intervention, was the analytical lead for the first part of the project and jointly drafted the paper with ABu. ABu worked with AJ on the data analysis and jointly drafted the paper with AS. ABo was the analytical lead and project manager for the latter part of the project and drafted parts of the paper. AJ conducted the data analysis and drafted parts of the paper. TC provided supervision and advice on statistical analysis, contributed to the interpretation of results, and revised drafts of the paper. DB conceived and oversaw the project and revised drafts of the paper. All authors read and approved the final manuscript and are accountable for the accuracy and integrity of the research reported.

**Study 5:** Sallis, A., Sherlock, J., Bonus, A., Saei, A., Gold, N., Vlaev, I., & Chadborn, T. (2019). Pre-notification and reminder SMS text messages with behaviourally informed invitation letters to improve uptake of NHS Health Checks: a factorial randomised controlled trial. *BMC Public Health*, 19(1), 1162.

ASal conceived the study and methodology, contributed to data interpretation, designed the intervention materials, wrote sections of the manuscript and critically revised its content with overall editorial responsibility. JS wrote an initial draft of the manuscript with support and guidance from ASal. AB managed, designed and

implemented the trial and data collection, conducted preliminary analysis and interpretation of findings. NG contributed to manuscript drafting and critically revised the manuscript, contributed to statistical analysis and interpretation of results. ASae conducted the statistical analysis and interpretation of results. IV contributed to interpretation of the data and critical revisions to the manuscript. TC oversaw the manuscript drafting and statistical analysis. All authors read and approved the final manuscript.

## **Studies 6 & 7**

“I agree that Anna Sallis provided the following contributions to these two papers for which I am lead and corresponding author.

Hallsworth, M., Berry, D., Sanders, M., Sallis, A., King, D., Vlaev, I., & Darzi, A. (2015). Stating appointment costs in SMS reminders reduces missed hospital appointments: findings from two randomised controlled trials. *PloS one*, 10(9), e0137306.

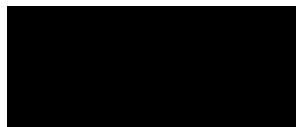
- Study conception: Anna attended and contributed to initial scoping meetings with colleagues at Imperial and drafted parts of the study proposal.
- Study design: Anna contributed to the study design for example attending and contributing to meetings with iPlato the SMS company to determine trial arms and design.
- Intervention design: Anna drafted SMS content and we jointly agreed which SMS to test.
- Manuscript draft: Anna made critical revisions to the manuscript and assisted in our response to reviewer comments.

Hallsworth, M., Chadborn, T., Sallis, A., Sanders, M., Berry, D., Greaves, F., Clements, L. & Davies, S. C. (2016). Provision of social norm feedback to high prescribers of antibiotics in general practice: a pragmatic national randomised controlled trial. *The Lancet*, 387(10029), 1743-1752.



- Study conception: Anna was involved in the conception of this study. Anna is an author on a report proposing the study idea<sup>1</sup> and Anna attended and contributed to project initiation and planning meetings.
- Intervention design: Anna helped to draft the intervention letters and proposed theoretical content.
- Trial implementation: Anna contributed to project management for example informing CCGs and prescribing advisors which practices would receive the letters.
- Manuscript drafting: Anna contributed comments and reworked some sections of the draft manuscript and assisted in our response to reviewer comments in particular on the behaviour change techniques.

Michael Hallsworth



Date: 26.01.2019

**Study 8:** Sallis, A., Bondaronek, P., Sanders, J., Yu, L., Harris, V., Vlaev, I., Sanders, M., Tonkin-Crine, S. & Chadborn, T. (2020) Prescriber commitment posters to increase prudent antibiotic prescribing in English General Practice: a cluster randomized controlled trial. *Antibiotics*, 9, 490; doi:10.3390/antibiotics9080490

AS and TC conceived the study. AS, TC & MS designed the study. MS conducted randomization. AS designed the intervention materials and executed the study with oversight from TC. JGS conducted fidelity checks and contributed to paper drafting. LY and VH conducted statistical analysis. AS & PB drafted the manuscript and conducted intervention BCT coding. All authors contributed to manuscript drafting and interpretation of findings.

---

<sup>1</sup> Pinder, R., Sallis, A., Berry, D. & Chadborn T. (2015) Behaviour Change for antibiotic prescribing: A literature review and behavioural analysis.

## Full biography of author

### Revise and Resubmit

Hanbury, A., **Sallis, A.**, Chadborn, T., Arber, M., Sanderson, A., Durlak, C. & Wood.

A pragmatic review of barriers and facilitators to health care professional cancer screening behaviours and a strategic behavioural analysis of interventions. *British Journal of Health Psychology*.

Haighton, C., Newbury-Birch, D., Durlak, C., **Sallis, A.**, Chadborn, T., Porter, L., Harling, M., & Rodrigues, A. Optimising Making Every Contact Count (MECC) interventions: A strategic behavioural analysis. *APA Health Psychology*.

Borek, A., Wanat, M., Atkins, L., **Sallis, A.**, Ashiru-Oredope, D., Beech, E., Butler, C., Chadborn, T., Hopkins, S., Jones, L., McNulty, C., Roberts, N., Shaw, K., Taborn, E. & Tonkin-Crine, S. Optimising antimicrobial stewardship interventions in English primary care: a behavioural analysis of qualitative and intervention studies. *BMJ Open*.

Tonkin-Crine, S., Schneider, A., Herd, N., Michie, S., Butler, C., Chadborn, T. & **Sallis, A.** Implementing practice-level nudge interventions to encourage prudent antibiotic prescribing in general practice: a mixed-methods process evaluation. *Antibiotics*

### Publications in date order

Atkins, L., Chadborn, T., Bondaronek, P., Ashiru-Oredope, D., Beech, E., Herd, N., Lyon, V., Gonzalez-Iraizoz, M., Hopkins, S., McNulty, C. & **Sallis, A.** (2020) Content and mechanism of action of national antimicrobial stewardship interventions on management of respiratory tract infections in primary and community care. *Antibiotics*, 9, 512; doi:10.3390/antibiotics9080512

**Sallis, A.**, Bondaronek, P., Sanders, J., Yu, L., Harris, V., Vlaev, I., Sanders, M., Tonkin-Crine, S. & Chadborn, T. (2020). Prescriber commitment posters to increase prudent antibiotic prescribing in English General Practice: a cluster randomized controlled trial. *Antibiotics*, 9, 490; doi:10.3390/antibiotics9080490

Wanat, M., Borek, A. J., Atkins, L., **Sallis, A.**, Ashiru-Oredope, D., Beech, E., ... & McNulty, C. A. (2020). Optimising Interventions for Catheter-Associated Urinary

Tract Infections (CAUTI) in Primary, Secondary and Care Home Settings. *Antibiotics*, 9(7), 419. <https://doi.org/10.3390/antibiotics9070419>

Atkins, L., **Sallis, A.**, Chadborn, T., Shaw, K., Schneider, A., Hopkins, S., ... & Lorencatto, F. (2020). Reducing catheter-associated urinary tract infections: a systematic review of barriers and facilitators and strategic behavioural analysis of interventions. *Implementation Science*, 15(1), 1-22.

Roope, L., Tonkin-Crine, S., Herd, N., Michie, S., Pouwels, K.B., Castro-Sanchez, E., **Sallis, A.**, Hopkins, S., Robotham, J.V., Crook, D. W., Peto, T., Peters, M., Butler, C., Walker, S. & Wordsworth, S. (2020). Reducing expectations for antibiotics in primary care: a randomised experiment to test the response to fear-based messages about antimicrobial resistance. *BMC Medicine*, 18, 1-11.

Ashiru-Oredope, D., Doble, A., Thornley, T., Saei, A., Gold, N., **Sallis, A.**, ... & Klinger, C. (2020). Improving Management of Respiratory Tract Infections in Community Pharmacies and Promoting Antimicrobial Stewardship: A Cluster Randomised Control Trial with a Self-Report Behavioural Questionnaire and Process Evaluation. *Pharmacy*, 8(1), 44. <https://doi.org/10.3390/pharmacy8010044>

Borek, A. J., Wanat, M., **Sallis, A.**, Ashiru-Oredope, D., Atkins, L., Beech, E., ... & Taborn, E. (2019). How can national antimicrobial stewardship interventions in primary care be improved? A stakeholder consultation. *Antibiotics*, 8(4), 207. <https://doi.org/10.3390/antibiotics8040207>

**Sallis, A.**, Gold, N., Agbebiyi, A., James, R. J. E., Berry, D., Bonus, A., ... & Chadborn, T. (2019). Increasing uptake of National Health Service Health Checks in primary care: a pragmatic randomized controlled trial of enhanced invitation letters in Northamptonshire, England. *Journal of Public Health*. <https://doi.org/10.1093/pubmed/fdz134>

**Sallis, A.**, Sherlock, J., Bonus, A., Saei, A., Gold, N., Vlaev, I., & Chadborn, T. (2019). Pre-notification and reminder SMS text messages with behaviourally informed invitation letters to improve uptake of NHS Health Checks: a factorial randomised controlled trial. *BMC Public Health*, 19(1), 1162.

**Sallis, A.**, Porter, L., Tan, K., Howard, R., Brown, L., Jones, A., ... & Chadborn, T. (2019). Improving child weight management uptake through enhanced National Child Measurement Programme parental feedback letters: A randomised controlled trial. *Preventive Medicine*, 121, 128-135. <https://doi.org/10.1016/j.ypmed.2019.01.023>

**Sallis, A.**, Attwood, S., Harper, H., Larsen, J., Berry, D., Vlaev, I., ... & Chadborn, T. (2019). A randomised trial of the effect of appearance versus health-framed messages on engagement with an online brief screening and alcohol reduction intervention. *Psychology & Health*, 34(8), 922-942. <https://doi.org/10.1080/08870446.2019.1579911>

Jones, L. F., Owens, R., **Sallis, A.**, Ashiru-Oredope, D., Thornley, T., Francis, N. A., ... & McNulty, C. A. (2018). Qualitative study using interviews and focus groups to explore the current and potential for antimicrobial stewardship in community pharmacy informed by the Theoretical Domains Framework. *BMJ Open*, 8(12). <http://dx.doi.org/10.1136/bmjopen-2018-025101>

**Sallis, A.**, Harper, H., & Sanders, M. (2018). Effect of persuasive messages on National Health Service Organ Donor Registrations: a pragmatic quasi-randomised controlled trial with one million UK road taxpayers. *Trials*, 19(1), 513.

Bhattacharya, A., Hopkins, S., **Sallis, A.**, Budd, E. L., & Ashiru-Oredope, D. (2017). A process evaluation of the UK-wide Antibiotic Guardian campaign: developing engagement on antimicrobial resistance. *Journal of Public Health*, 39(2), e40-e47. <https://doi.org/10.1093/pubmed/fdw059>

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## Abstract

This thesis reports eight pragmatic health behaviour change research trials applying behavioural insights to message design in a government policy context and conducted between 2013 and 2015 (published between 2015 and 2020). The papers are presented in three chapters according to the intervention target group: public, patients, healthcare professionals.

The interventions were designed using a behavioural insights approach. Applied experimental methodology is used in each of the field trials. All but one intervention impacted upon the main outcome measures. The impactful interventions are implemented in national policy to varying extents as described in the thesis.

In addition to the presentation of the papers and their policy impacts, this thesis asks: **Can behavioural insights frameworks optimise the application of health psychology tools and frameworks to behaviour change intervention design in a policy context? If so, how?**

To answer this question each intervention is described according to health psychology and behavioural insights frameworks commonly used by behaviour change practitioners in government.

The findings suggest that behavioural insights frameworks can offer a wider perspective on the influences on behaviour and identifying additional behaviour change techniques which could improve the content of health psychology tools and frameworks.

However, whilst the approach to field testing in the relevant context used in the trials presented is respectable in terms of (i) external validity (ii) impact on the behavioural outcomes and (iii) direct implementation into policy, the selection of behaviours to change, determinants to target and techniques to target them requires more robust scientific method and strategic thinking than the behavioural insights frameworks applied currently offer.

The thesis concludes that behavioural scientists can have a greater impact on policy if disciplines work together to integrate the best of their approaches, tools and frameworks and apply this alongside full consideration of the systems within which behaviour takes place.

## Length of thesis

13,421 words (excluding abstract).

**Table 1: An overview of included studies**

	Short title/aim	Target group and setting	Study design	Intervention	Outcome measure	Policy implementation
<b>Part 1: Increasing uptake of health interventions in the general public</b>						
<b>Study 1</b>	Increasing organ donation registrations (ODR)	1 million members of the public renewing their road tax online.	Quasi-RCT	Online message framing intervention inviting people to join the ODR.	Joining the organ donation register.	Best performing message implemented across 30 government websites generating an additional 529,000 registrations. Effect replicated in other published trials.
<b>Study 2</b>	Increasing engagement in screening and brief alcohol intervention on the Drinkaware website.	Public accessing Drinkaware website	Randomised trial	Online health v appearance framed messaging to users of the Drinkaware website.	Completion of brief alcohol screening tool and accessing further resources.	Used in campaigns.
<b>Study 3</b>	Increasing uptake of child weight management services.	Parents of overweight school children.	RCT	Letter informing parents of overweight children of their weight status using a visual tool, social norms messaging and pre-populated weight management service booking forms. Part of the National Child Measurement Programme.	Enrolment at weight management services	National template letter amended.

Part 2: Increasing patient attendance at healthcare appointments						
<b>Study 4</b>	Increasing attendance at NHS Health Checks in Medway.	Primary care patients (NHS)	Quasi-RCT	Letter to patients due an NHS Health Check.	Uptake of NHS Health Checks	National template letter amended. Effect size replicated in study 5.
<b>Study 5</b>	Increasing attendance at NHS Health Checks in Southwark.	Primary care patients (NHS)	Factorial RCT	Letters & SMS primer and reminder to patients due an NHS Health Check.	Uptake of NHS Health Checks	National template letter amended.
<b>Study 6</b>	Reducing missed hospital outpatient appointments.	Secondary care patients (NHS)	RCT x 2	Behaviourally informed content of SMS reminder to patients due to attend an outpatient appointment.	Did Not Attends rates.	Anecdotal evidence of wide spread use across the NHS. Effect replicated in other published trials.
Part 3: Reducing inappropriate antibiotic prescribing in General Practice						
<b>Study 7</b>	Reducing GP antibiotic prescribing with a social norms letter from England's Chief Medical Officer.	General Practices with high antibiotic prescribing rates (NHS)	Factorial RCT	Social norms letter to high prescribers from high profile messenger.	Antibiotic prescribing rates.	Letter sent every year by England's Chief Medical Officer. Replicated effects in Ireland, Canada and Australia. Being extended to secondary care.
<b>Study 8</b>	Reducing GP antibiotic prescribing using antimicrobial stewardship commitment posters and patient telephone phone messaging.	Prescribers in General Practice (NHS)	RCT	Prescriber antimicrobial stewardship commitment poster and automated telephone message to patients calling general practice to book appointments.	Antibiotic prescribing rates.	Further trial planned to re-test impact of phone message alone.

NB: All interventions are described according to the Template for Intervention Description and Replication (TIDieR) checklist (Hoffman et al., 2014) at Appendix D.

## Chapter one: Background and context

### 1.1 Intervening to prevent non-communicable disease

Worldwide, around two thirds of deaths are attributed to non-communicable disease (World Health Organisation, 2014b). The majority are due to cardiovascular disease, cancers, respiratory diseases and diabetes (World Health Organisation, 2014a). The World Health Organisation (WHO) estimates that non-communicable disease accounts for around 89% of all deaths in the United Kingdom (WHO, 2014b). Many of the conditions are preventable through lifestyle behaviour change, for example reducing sedentary behaviour, stopping smoking, limiting alcohol consumption, eating a healthy diet and exercising regularly (Kontis et al., 2014). The impact of non-communicable disease on NHS resources is considered to be unsustainable (House of Lords Select Committee, 2017). The importance of behavioural science applied to communicable disease is also evident especially in the current (i.e. COVID 19) climate.

Health outcomes are the result of individual behaviour and decisions by government about whether and how to intervene to influence these choices, as well as the wider social determinants of health (Kelly, 2016). In the field of public health there has been much debate about the balance of preserving personal freedom and protecting the common good (Nuffield Council on Bioethics, 2007). Simply educating the public to reflect on the impact of their lifestyle choices has had limited effect on behaviour change (Marteau, Hollands & Fletcher, 2012).

The Nuffield Council on Bioethics developed an intervention ladder which describes a range of approaches that governments can take to design policy and to change the behaviour of its citizens. The ladder describes a hierarchy of how much personal liberties are restricted, starting with the most coercive method of eliminating choice (Nuffield Council on Bioethics, 2007). See Table 2.

**Table 2: Intervention Ladder (Nuffield Council on Bioethics, 2007)**

Eliminate choice. Regulate in such a way as to entirely eliminate choice, for example through compulsory isolation of patients with infectious diseases.
Restrict choice. Regulate in such a way as to restrict the options available to people with the aim of protecting them, for example removing unhealthy ingredients from foods, or unhealthy foods from shops or restaurants.
Guide choice through disincentives. Fiscal and other disincentives can be put in place to influence people not to pursue certain activities, for example through taxes on cigarettes, or by discouraging the use of cars in inner cities through charging schemes or limitations of parking spaces.
Guide choices through incentives. Regulations can be offered that guide choices by fiscal and other incentives, for example offering tax-breaks for the purchase of bicycles that are used as a means of travelling to work
Guide choices through changing the default policy. For example, in a restaurant, instead of providing chips as a standard side dish (with healthier options available), menus could be changed to provide a more healthy option as standard (with chips as an option available).
Enable choice. Enable individuals to change their behaviours, for example by offering participation in a NHS 'stop smoking' programme, building cycle lanes, or providing free fruit in schools.
Provide information. Inform and educate the public, for example as part of campaigns to encourage people to walk more or eat five portions of fruit and vegetables per day
Do nothing or simply monitor the current situation.

## 1.2 Intervention design using behavioural insights, nudge and health psychology

An approach adopted by the UK Government to influence behaviour whilst preserving individual liberty is known as *nudge* (Thaler & Sunstein, 2009). *Nudge* is defined as “a means of encouraging or guiding behaviour, but without mandating or instructing, and ideally without the need for heavy financial incentives or sanctions” (Halpern, 2019, p. 22). The emphasis is on changing behaviour without restricting or eliminating choice, effectively enabling individuals to make better choices for themselves without traditional policy measures such as regulation or taxation. Its origins lie in behavioural economics and social psychology. The approach recognises that the standard economic model used to predict and explain human decision-making (e.g. Expected Utility Theory) is based on a faulty assumption that given the full information we will make decisions in our best interest (Friedman, 1976; Thaler & Sunstein, 2009). However, we often make choices which are not in our best interests such as eating too much, not exercising and smoking.

This can be explained using dual process theories of behaviour which describe behaviour occurring as a result of two interacting processes or systems: reflective processes and automatic or impulsive processes (Strack & Deutsch, 2004). Automatic processes are characterised as fast, effortless and unconscious, acting through associative links, drives, needs, emotions and habits whereas reflective processes are thought to be effortful, slower, deliberative and controlled acting through plans, goals and intentions (Kahneman, 2011). Dual process theories would explain the failure of good intentions being enacted because of decisions made via reflective processes being interrupted or overcome by competing automatic processes such as environmental cues or drives. Automatic processes stimulated by environmental cues are believed to account for more of our behaviour than reflective processes (Marteau, et al., 2012).

The automatic system is thought to help us to navigate the complex world around us (Thaler & Sunstein, 2009). As we cannot attend to all the information and cues that we encounter, we use mental short-cuts or rules of thumb, also known as biases and heuristics, to help inform the multiple decisions needed in everyday life (Tversky & Kahneman, 1974). However, these short-cuts can lead to sub-optimal decision-

making due to biases in our cognitive processing for example procrastination and stereotyping (Thaler & Sunstein, 2009).

The importance of the automatic system is recognised in a key publication for government behaviour change practitioners known as MINDSPACE. The most 'robust effects' on behaviour, operating largely through the automatic system are identified and represented through the mnemonic MINDSPACE which stands for 'messenger, incentives, norms, defaults, salience, priming, affect, commitment, and ego' (Dolan, Hallsworth, Halpern, King, Metcalfe & Vlaev, 2012). It is intended as a checklist for policy-makers to integrate psychological insights about the influence of the automatic system on human behaviour into policy design (Dolan, Hallsworth, Halpern, King & Vlaev, 2010). EAST (Easy, Attractive, Social and Timely) was also published to complement MINDSPACE aiming to provide a simpler, more practical guide for policy-makers (Algate, Gallagher, Nguyen, Ruda & Sanders, 2015).

These seminal publications and successful demonstration of their application to behaviour change in policy, for example through studies one, six and seven of this thesis, (see 'Behavioural Insights and Public Policy: Lessons from Around the World' Organisation for Economic Co-operation and Development (OECD), 2017, p. 264-272), facilitated the creation of *behavioural insights* teams across multiple UK and international government departments (OECD, 2017). " *Behavioural insights* are lessons derived from the behavioural and social sciences, including decision making, psychology, cognitive science, neuroscience, organisational and group behaviour" (OECD, 2017).

An international survey of over 60 public bodies across 23 OECD countries explored the application of behavioural insights and collected case studies across a wide range of policy areas. The survey showed that the use of behavioural insights in public bodies is not just a passing fad or a trend. Limited, if any, resistance to its use in policy was observed. However, they caution that to retain reputation and trust "there must be guiding principles and standards must be set to guide future applications" (OECD, 2017, p4). They also call for results to be published and shared.

In some policy areas the application of behavioural insights (BI) was new but in public health, behaviour change has been a key tenet for many years and one that is the focus for Health Psychologists. Several tools for understanding behaviour (e.g. Cane et al., 2012) and designing behavioural interventions (e.g. Bartholomew, Parcel & Kok, 1998; Craig et al., 2008; Green & Kreuter, 1999; Michie, van Stralen & West, 2011; Murray et al., 2010) already exist.

Interventions designed from a BI perspective are largely aimed at addressing our responses to contextual influences (i.e. environmental, structural or social) at a population level. Interventions are usually based on techniques thought to be processed through the automatic system, as opposed to targeting individual agency, allowing them to be applied at distance and scale. The result is low cost, low resource interventions utilising existing intervention points and outcome measures. These wider influences on behaviour and the cognitive biases mentioned earlier arising from automatic processes are considered to apply more broadly at population level than the varied content of individuals attitudes and beliefs forming the basis of many interventions based on traditional health psychology models, for example the Theory of Planned Behaviour (Ajzen, 1991) and the Health Belief Model (Rosenstock, 1974). Many such social cognition models focus on explaining behaviour through reflective processing (Dixon & Johnston, 2020) although, more recently, the field of health psychology (HP) has also begun to recognise the role of the automatic system and environmental cues on behaviour. One such example is the Behaviour Change Wheel (BCW) (Michie et al., 2011) which is also widely used in government. Development of the BCW involved a systematic review of behaviour change frameworks with the aim of producing a framework with comprehensive coverage of intervention types, coherence and links to an overarching model of behaviour (Michie et al., 2011). MINDSPACE was one of 19 frameworks included in the review. It was criticised, for being incoherent as it includes modes of delivery (e.g. messenger), individual characteristics (e.g. ego), mechanisms of action (e.g. priming), policy strategies (e.g. defaults) and other related psychological constructs (e.g. affect) and, for excluding certain potentially relevant policy options such as



regulation and legislation (Michie & West, 2013b) hence this new framework (the BCW) for designing and characterising interventions was proposed.

The BCW incorporates a model for understanding influences on behaviour known as COM-B (Capability, Opportunity, Motivation – Behaviour). This is a dual process model recognising the influence of automatic and reflective motivation systems, social and physical (environmental) opportunities and psychological and physical capability on behaviour. COM-B is linked to Intervention Functions (also known as Intervention types) and Policy Categories or channels for delivering change via those influences. COM-B is linked to a more detailed framework for understanding influences on behaviour known as the Theoretical Domains Framework (TDF) (Cane et al., 2012) and a more detailed list of techniques for changing behaviour known as the Behaviour Change Technique Taxonomy Version 1 (BCT-T V1), (Michie et al., 2013a). These can be used alongside the BCW when designing or characterising interventions. Attempts to link the influences on behaviour (via an extended TDF using additional Mechanisms of Action) and techniques for changing behaviour (using BCTs) are progressing (Cane, Richardson, Johnston, Ladha & Michie, 2015; Carey et al., 2019; Connell et al., 2019; Johnston et al., 2020).

The authors of the BCW have published a guide for achieving behaviour change in local government to enable local governments to operationalise the approach (West, Michie, Atkins, Chadwick & Lorencatto, 2019). A national government guide is also imminent. Both guides include examples of how the approach is already being applied in local and national government.

## 1.3 Introduction to thesis

### 1.3.1 Definitions

Common terminology used in the thesis are defined below:

**Theory:** “a set of concepts and/or statements which specify how phenomena relate to each other. Theory provides an organizing description of a system that accounts for what is known and explains and predicts phenomena.” (Davis, Campbell, Hildon, Hobbs & Michie, 2015, Definition of key terms section).

A **model** is described according to the definition given in the BCW paper taken from the Oxford English Dictionary: 'a hypothetical description of a complex entity or process' (Michie et al., 2011, Establishing criteria for usefulness section).

**Framework:** "a system of rules, ideas or beliefs that is used to plan or decide something.' (Cambridge online dictionary, n.d).

**Tool:** "something that helps you do a particular activity." (Cambridge online dictionary, n.d)

### 1.3.2. Thesis approach

The Medical Research Council and National Institute for Health Research in the UK recently updated its guidance on how to develop and evaluate complex interventions to improve health and healthcare (see O'Cathain et al., 2019). Nine approaches to intervention development were identified: partnership intervention development, target-population centred, evidence and theory based, implementation based, efficiency based, stepped or phased, intervention specific, combination and pragmatic. The interventions in this thesis are best categorised as 'combination based' defined as "Published approaches to intervention development are combined" (O'Cathain et al., 2019, Table 2, bullet 8). The interventions included are a combination of 3 types: 'implementation based' defined as "Interventions are developed with attention to ensuring the intervention will be used in the real world if found to be effective at the evaluation phase" (O'Cathain et al., 2019, Table 2, bullet 4); 'pragmatic' which are aimed at evaluating "the effectiveness of interventions in real-life routine practice condition" (Patsopoulos, 2011, Abstract) and 'evidence and theory based' whereby "interventions are based on combining published research evidence and existing theories" (O'Cathain, 2019, Table 2, bullet 3).

The *behavioural insights approach* is not mentioned in the Medical Research Council and National Institute for Health Research guidance. Where the description is used in this thesis it implies the combination approach discussed above, in addition to the following further key features: i) aimed at determining effectiveness not efficacy, ii) employing an inductive approach using experimental methodology in real world

settings (see Test, Learn, Adapt report by Haynes, Goldacre & Torgerson, 2012; OECD, 2017), and where possible, iii) making use of routinely collected data as outcome measures and iv) delivery of interventions through changes to existing systems (Haynes et al., 2012).

As such, the aim of the trials was to make small changes to existing processes which, when applied to large populations, accumulate to have a larger societal impact. The use of this approach in public policy is relatively new and as such often the insights used in the interventions may never have been tested outside the laboratory and have rarely been tested at scale or applied in context, to large and diverse populations. This is one reason why testing through experimental designs is a key feature of BI interventions (OECD, 2017) including those presented in this thesis. The approach is aimed at determining robustly what worked, in the relevant context and to facilitate implementation into policy rather than to advance theory (OECD, 2017).

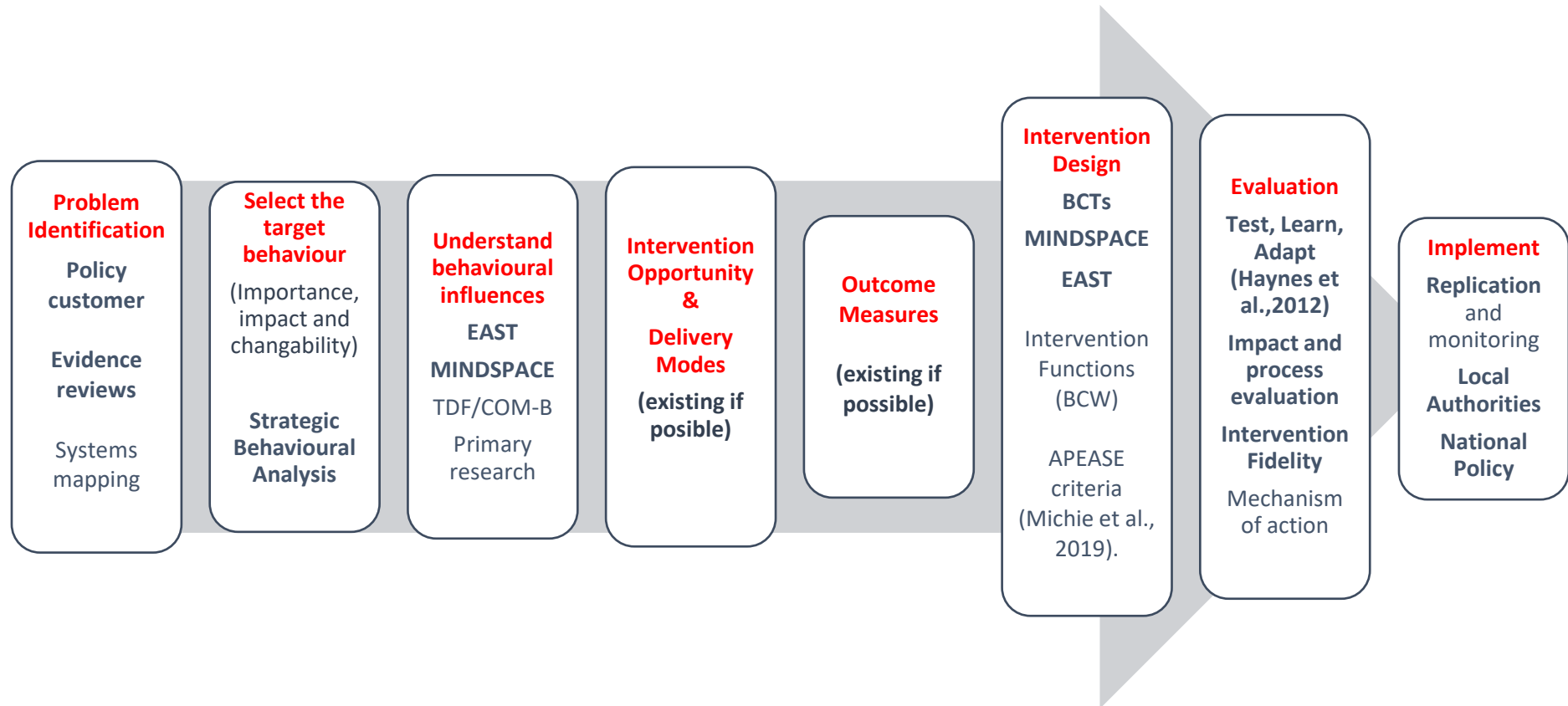
However, this thesis provides an opportunity to reflect on the interventions using popular BI (i.e. MINDSPACE and EAST) and HP frameworks (i.e. BCW and BCT-T V1), all of which inspired the trials, to consider the merits of each approach. Each intervention is coded into these frameworks (see Appendix C for coding details). The purpose is to consider how the frameworks can be better aligned into a more integrated behavioural science approach allowing policy-makers to use the best available tools from both disciplines. This thesis is written by a Health Psychologist therefore health psychology frameworks are used as a starting point to understand whether and how they can be optimised using behavioural insights leading to the following research question:

**Can behavioural insights frameworks optimise the application of health psychology tools and frameworks to behaviour change intervention design in a policy context? If so, how?**

Figure 1 provides a logic map of the tools and approaches discussed in this thesis in relation to intervention design and evaluation.



Figure 1: Logic model of ‘combined approach’ to intervention design



NB: Emboldened text indicates frameworks or approaches utilised in some or all of the trials presented.

### 1.3.3 Thesis outline

This thesis brings together eight applied and pragmatic field trials conducted between 2013 and 2015 (published between 2015 and 2020) aimed at changing health behaviours. The papers are presented in three sections according to the intervention target groups.

**Chapter two** presents three papers aimed at changing the general public's health behaviour in relation to organ donation registrations, use of an alcohol brief screening intervention and enrolment in weight management services.

**Chapter three** describes three trials to change the behaviour of NHS patients; two to increase the uptake of NHS Health Checks and one to reduce missed hospital appointments.

**Chapter four** presents two trials aimed at reducing General Practitioners antibiotic prescribing.

**Chapter five** discusses the research question based upon the papers presented and additional coding into behavioural frameworks and concludes the thesis.

## Chapter two: Increasing uptake of health interventions in the general public

### 2.1 Study characteristics

#### 2.1.1 Target behaviours

The first three field experiments aim to increase uptake of:

- (i) consent to organ donation (study 1),
- (ii) alcohol screening and brief interventions (study 2)
- (iii) family weight management services (study 3).

#### 2.1.2 Study methodology

The following methodologies were employed across studies one, two and three respectively: quasi-randomised controlled trial, randomised trial and cluster randomised controlled trial.

#### 2.1.3 Intervention context and populations

The first two studies have national reach with the interventions hosted on websites. Study one involved a prompted (as opposed to mandated) choice intervention, with a new intervention point added to an existing process on the GOV.UK website. The intervention can also be described as employing a message immediacy approach whereby individuals are exposed to messages that link decisions closely with the desired behaviour (i.e. joining the organ donation register) in an environment where the behaviour can be easily and immediately enacted (King, Williams, Harrison, Morgan & Havermahl, 2012). The second study is also delivered via an existing website and aims to optimise uptake of a pre-existing alcohol screening tool through variation in messaging on the homepage of the website. The third intervention covers three counties in England and aims to optimise outcomes for an existing process; letters sent to parents of overweight and very overweight school children from local authority public health departments encouraging uptake of family weight management services.

#### 2.1.4 Outcome data

Existing sources of outcome data are used across the trials making them low cost and non-burdensome to deliver. The primary outcome for study one utilised a pre-existing data source: the organ donation register maintained by National Health Service Blood and Transplant (NHSBT). Study two used google analytics data collected by Drinkaware integral to their website. Study three involved local weight management services sharing their data on service uptake with the researchers during the study period.



## 2.2 Study 1: What is the impact of a prompted choice intervention on organ donation registrations?

Sallis, A., Harper, H., & Sanders, M. (2018). Effect of persuasive messages on National Health Service Organ Donor Registrations: a pragmatic quasi-randomised controlled trial with one million UK road taxpayers. *Trials*, 19(1), 513.

### 2.2.1 Background

A shortage of organs available for transplantation is causing loss of life (NHSBT, 2019). Increasing the number of individuals on the National Health Service (NHS) Organ Donor Register (ODR) is one way to address the shortage of organs.

### 2.2.2 Method

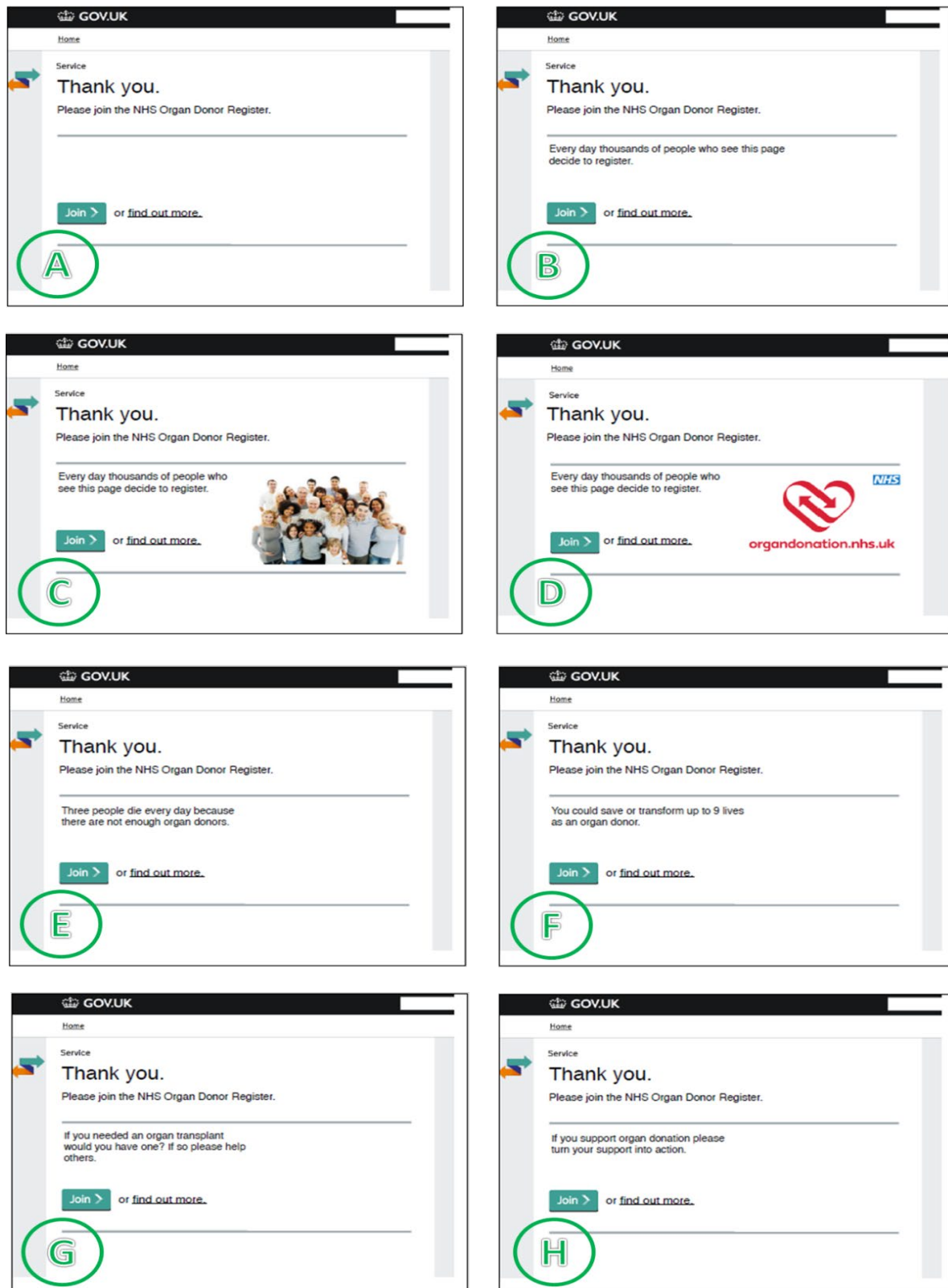
In this pragmatic, parallel group, quasi-randomised controlled trial, all drivers in England, Scotland and Wales renewing their vehicle tax or registering for a driving licence online, during a 4-week period were quasi-randomly assigned to see one of eight variants of a web page at the end of their transactions. Web-users were asked to join the ODR by clicking a 'join' radio button which directed them to the ODR registration page where they could complete a short online form. Alternatively, they could close the page or click a link to 'Find out more', which took them to the NHSBT home page. The eight variants were a control prompt inviting registration to the ODR or the same prompt plus one of seven theoretically informed persuasive messages (see figure 2). The primary outcome measure was participants completing the online registration form (i.e. sign-ups)<sup>2</sup>.

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<sup>2</sup> The term 'sign-ups' is used as opposed to registrations as some people had already registered and were therefore duplicates. Duplicates were not reported so 'sign ups' is used instead.

**Figure 2: Screen shots of intervention messages**

A = Control; B = Social norms; C = Social norms and image; D = Social norms and logo; E = Loss frame; F = Gain frame; G = Reciprocity; H = Cognitive dissonance.



### 2.2.3 Summary of intervention coding

The intervention targets physical opportunity (COM-B) through the physical addition of this new 7.1. 'Prompt/cue' and via BCT 12.1 'Adding objects to the environment' delivered through the Intervention Function (IF) 'Environmental restructuring'. A broader range of COM-B components were targeted through intervention message content (i.e. social opportunity, reflective and automatic motivation) using a range of BCTs. The motivational elements are coded as IF 'persuasion' and the social elements IF 'environmental restructuring'.

The intervention descriptions according to MINDSPACE and EAST show overlaps with COM-B and BCT coding (e.g. Prompts, social norms/social opportunity). For some messages the BCTs better describe their content (e.g. Variant F describes three associated BCTs compared to the generic descriptors in the BI frameworks; 'people helping people' and 'salience'). For other messages, BI offers more detail (e.g. reciprocity and desire for fairness for variant G where no relevant BCTs were found).

**Table 3: Study 1 Intervention coding**

Intervention component	COM-B i	Behaviour Change Techniques ii	Intervention Function iii	MINDSPACE (sub-components) iv	EAST (sub-components) v
<b>Variant A (Control)</b> Overall intervention (i.e. placing an invitation to join the ODR on a road tax website).	Physical opportunity	7.1 Prompt/cue 12.1 Adding objects to the environment	Environmental restructuring		Easy (Friction costs) Timely (Prompts)
<b>Variant B (Social norms)</b> <i>Everyday thousands of people who see this page decide to register.</i>	Social opportunity	6.2 Social comparison	Environmental restructuring	Norms	Social (Network nudge)
<b>Variant C (Social norms plus image of people)</b> <i>Everyday thousands of people who see this page decide to register.</i>	Social opportunity	6.2 Social comparison	Environmental restructuring	Norms Salience	Social (Network nudge)
<b>Variant D (Social norms plus NHSBT logo)</b> <i>Everyday thousands of people who see this page decide to register.</i>	Social opportunity	6.2 Social comparison 9.1 Credible source	Environmental restructuring	Messenger Salience	
<b>Variant E (Loss frame)</b> <i>Three people die every day because there are not enough organ donors.</i>	Reflective and automatic motivation Social opportunity	5.3 Information about social/ environmental consequences. 13.2 Framing/reframing 15.3 Vicarious consequences	Persuasion Environmental restructuring	Loss aversion (Incentives) Salience (framing)	Social (people helping people)

<b>Variant F (Gain frame)</b>  <i>You could save or transform up to 9 lives as an organ donor.</i>	Reflective and automatic motivation  Social opportunity	5.1 Information about health consequences  13.2 Framing/ reframing  15.3 Vicarious consequences	Persuasion  Environmental restructuring	Saliency (Framing)	Social (people helping people)
<b>Variant G (Reciprocity)</b>  <i>If you needed an organ transplant would you have one? If so, please help others.</i>	Reflective and automatic motivation  Social opportunity		Persuasion  Environmental restructuring	Commitment (Reciprocity)  Ego (Desire for fairness)	Social (people helping people)
<b>Variant H (Cognitive dissonance)</b>  <i>If you support organ donation, please turn your support into action.</i>	Reflective and automatic motivation	13.3. Incompatible beliefs	Persuasion	Commitment  (Need for consistency, Implementation intentions).	

- i. **COM-B: Capability (Physical or Psychological), Opportunity (Physical or Social), Motivation (Reflective or Automatic) – Behaviour.** See appendix 1 for definitions.
- ii. **Derived from Behaviour Change Technique Taxonomy Version 1 (Michie et al, 2013).** See appendix A, figure 14 for definitions.
- iii. **Behaviour Change Wheel Intervention Function (Education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring).** See appendix A, table 11 for definitions.
- iv. **MINDSPACE (Messenger, Incentives, Norms, Defaults, Saliency, Priming, Affect, Commitments, Ego) – see appendix B, table 14 for sub-components derived from the MINDSPACE map (Appendix B, figure 15). (Dolan et al., 2010)**
- v. **EAST (Easy, Attractive, Social, Timely) – see appendix B, table 15 for sub-components.**
- vi. **See appendix C for full description of coding process**

### 2.2.4 Results

Data for 1,085,322 website users were included. 1171 more sign-ups to the ODR were completed under the most effective message (G reciprocity) compared to the control prompt (G reciprocity:  $n = 4256$ , A control:  $n = 3085$ ; odds ratio, OR 1.38, 95% confidence interval 1.32–1.45,  $p < 0.001$ ). The loss-framed message (Variant E) was as effective. All messages increased sign-ups compared to the control prompt except the social norms message plus image (Variant C), ( $n = 2879$ ; OR 0.94, 95% confidence interval 0.89–0.99,  $p < 0.05$ ).

### 2.2.5 Discussion

The two most effective messages (E loss frame and G reciprocity) used persuasion to target reflective and automatic motivation highlighting the consequences of one's own actions on the health outcomes of others. When faced with the idea of donating one's organs, individuals can feel the 'ick factor' which is a gut reaction or instant disgust response (O'Carroll, Foster, McGeechan, Sandford & Ferguson, 2011). These messages may have provoked reflective thought to overcome this automatic negative reaction. Short persuasive messages alongside a prompt can persuade more ODR sign-ups for individuals renewing their road tax than a prompt alone. Future trials could combine concepts, as well as investigating whether some messages resonate more with certain groups for whom organs are in short supply.

### 2.2.6 Policy impact

The results of this trial provide the only evidence, in context, about which messages are most effective at persuading individuals to join the ODR after renewing their road tax. Without this trial a message less effective than no message at all could have been used. Since the trial in 2013, the reciprocity message has been implemented across 25 government end-of-transaction websites on GOV.UK, resulting in 529,000 new registrations to the ODR up to 31st October 2017. Currently road tax is administered through automatic renewals and direct debits reducing the number of visitors to the website. The findings have been replicated in at least two separate trials (O'Carroll, Haddow, Foley & Quigley, 2017; Robitaille, Mazar, Tsai, Haviv & Hardy, 2020).

## 2.3 Study 2: What is the effect of appearance versus health framed messages on engagement with an online brief screening and alcohol reduction intervention?

Sallis, A., Attwood, S., Harper, H., Larsen, J., Berry, D., Vlaev, I., ... & Chadborn, T. (2019). A randomised trial of the effect of appearance versus health-framed messages on engagement with an online brief screening and alcohol reduction intervention. *Psychology & Health*, 34(8), 922-942.

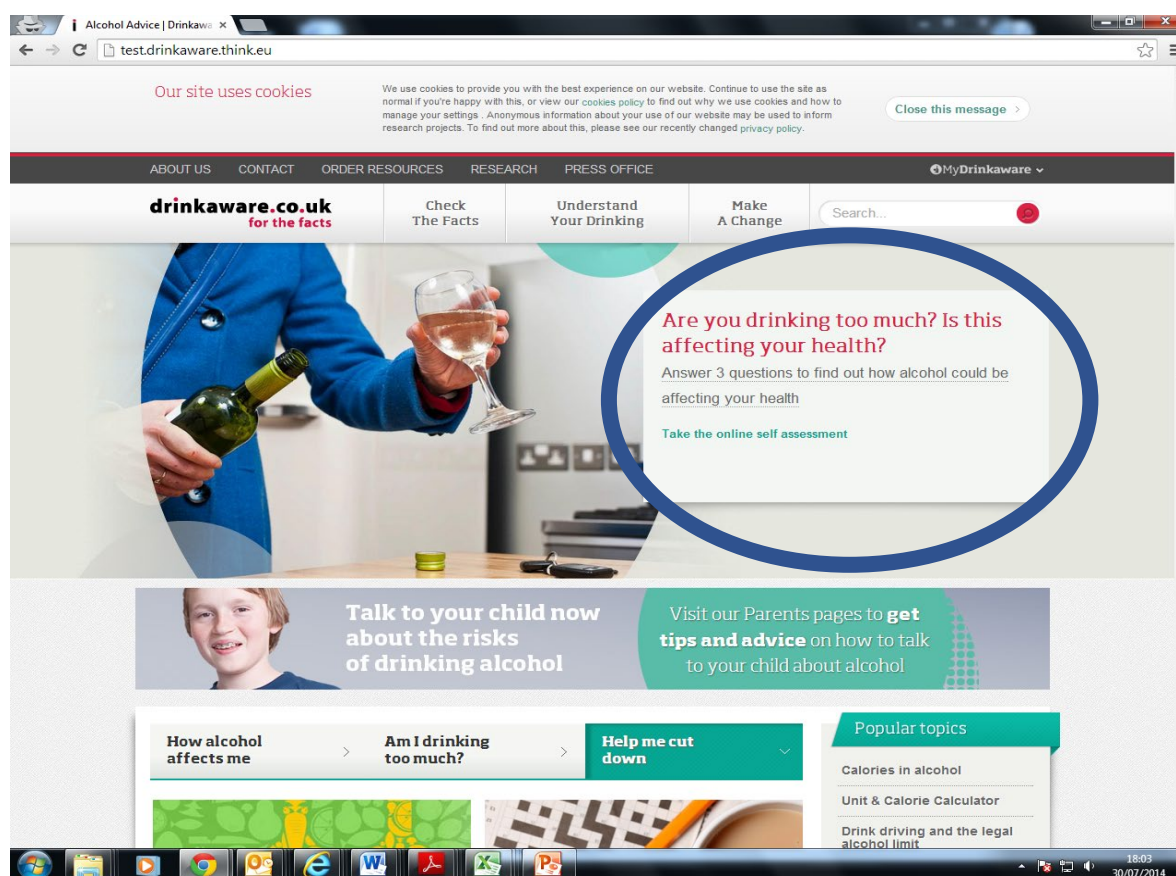
### 2.3.1 Background

In 2016, 31% of men and 16% of women drank over the low risk drinking guidelines of no more than 14 units of alcohol per week (NHS Digital, 2016). Several self-help digital tools are publicly available for those seeking support to reduce their alcohol consumption. One of the widest reaching of these is the Drinkaware Trust website.

### 2.3.2 Method

Visitors to the Drinkaware website were exposed to appearance (n = 51,588) or health framed messages (n = 52,639) directing them towards an AUDIT-C risk screening questionnaire. Users completing this questionnaire were given feedback on their risk level, extended frame-congruent information and were directed to further online resources. The primary outcome was completion of the AUDIT-C. The secondary outcome was whether the participant accessed any of four further resources. Sub-group analysis was also conducted.

Figure 3: Screen shot of home page displaying health message.



### 2.3.3 Summary of intervention coding

The persuasive messaging used is intended to impact reflective motivation through changes in beliefs and potentially through emotional or automatic processing regards the statement about the impact of alcohol on mental health and more generally through the salience and novelty of the messaging. The main BCT for both interventions was 2.7 'Feedback on outcomes of behaviour'. The content of the health and appearance messaging is coded as BCT 5.1 'Information about health consequences' and 5.2 'Salience of consequences' assuming the information is perceived as novel. The MINDSPACE concept of 'desire to preserve self-image' may be a good descriptor for the appearance messaging.

BI frameworks highlight the same framing, affective and salient aspects of the interventions as the BCTs but also add the concept of 'hyperbolic discounting' and 'present bias' to describe the intervention as whole referring to the inclusion of immediate and long-term harms in both message variants. Intervention messages



were tailored according to risk frame which is described as 'personalisation' in the EAST framework.

**Table 4: Study 2 Intervention coding**

Intervention component	COM-B i	BCTs ii	Intervention Function iii	MINDSPACE (plus any relevant sub-components) iv	EAST (plus any relevant sub-components) v
<b>Overall intervention</b> (i.e. Invitation to take the AUDIT C and providing frame congruent health and appearance feedback dependent upon risk level (with immediate and future consequences) on drinking behaviour)	Psychological capability  Reflective and automatic motivation	2.7 Feedback on outcomes of behaviour  13.2 Framing/reframing  13.3 Incompatible beliefs	Education  Persuasion	Incentives (Hyperbolic discounting)  Salience (Framing)	Timely (Present bias)  Attractive (Personalise),
Health frames	Reflective and automatic motivation	5.1 Information about health consequences (e.g. Cancer)  5.2 Salience of consequences  5.3 Information about social and environmental consequences (e.g. burping and flatulence)  5.6 Information about emotional consequences (e.g. depression)	Persuasion	Salience (Framing)	
Appearance frames	Reflective and automatic motivation	5.1 Information about health consequences (e.g. skin, weight)  5.2 Salience of consequences	Persuasion	Salience (Framing)  Ego (Desire to preserve self-image)	

- i. **COM-B: Capability (Physical or Psychological), Opportunity (Physical or Social), Motivation (Reflective or Automatic) – Behaviour. See appendix 1 for definitions.**
- ii. **Derived from Behaviour Change Technique Taxonomy Version 1 (Michie et al, 2013). See appendix A, figure 14 for definitions.**
- iii. **Behaviour Change Wheel Intervention Function (Education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring). See appendix A, table 11 for definitions.**
- iv. **MINDSPACE (Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, Ego) – see appendix B, table 14 for sub-components derived from the MINDSPACE map (Appendix B, figure 15). (Dolan et al., 2010)**
- v. **EAST (Easy, Attractive, Social, Timely) – see appendix B, table 15 for sub-components.**
- vi. **See appendix C for full description of coding process**

### 2.3.4 Results

The appearance framed message led to a small but significant increase in the number of users completing the AUDIT-C compared to the health framed message ( $n = 3,537$ , 6.86% versus  $n = 3,355$ , 6.37%,  $p < 0.01$ ). Conversely, following subsequent risk feedback, users exposed to extended health framed information were more likely to access further resources ( $n = 1,146$ , 2.17% versus  $n = 942$ , 1.83%,  $p < 0.01$ ).

### 2.3.5 Discussion

Before the screening test, the messages are abstract, general statements about the health and appearance impacts of alcohol. Given that people may be more immediately concerned about their image rather than their health (Gerrard, Gibbons, Lane & Stock, 2005) it is perhaps not surprising that appearance-related messages prove more influential at this earlier stage. However, after receiving more specific, personalised feedback about the likely outcomes of their own behaviour via extended messages the health consequences (e.g. bowel cancer, depression and anxiety, osteoporosis) are perceived to be more severe compared to the consequences for appearance harms (Hayes, Schimel, Arndt & Faucher, 2010; Jessop, Albery, Rutter & Garrod, 2008). This research highlights the potential usefulness of multi-level interventions for alcohol reduction interventions tailored to the message purpose.

### 2.3.6 Policy impact

Drinkaware have been using both message frames in their campaigns as sub-group analysis found that the health and appearance messages are engaging different audiences at different stages of the user journey. For example, they have used appearance messages to target females aged 35 and older in the Cut Back Feel Better campaign as sub-group analysis suggested this would be effective.

## 2.4 Study 3: Can enhanced National Child Measurement Programme parental feedback letters improve uptake of child weight management services?

Sallis, A., Porter, L., Tan, K., Howard, R., Brown, L., Jones, A., ... & Chadborn, T. (2019). Improving child weight management uptake through enhanced National Child Measurement Programme parental feedback letters: A randomised controlled trial. *Preventive medicine*, 121, 128-135.

### 2.4.1 Background

Children with obesity are at greater risk of developing diabetes, heart disease and some cancers over their lifespan (Biro & Wien, 2010). In 2016/17, 22.6% of 4-5 year olds were overweight (OW) or had obesity (i.e. very overweight; VOW), rising to 34.3% of 10-11 year olds (NHS Digital, 2017). The National Child Measurement Programme (NCMP) informs parents of their child's weight status by letter to enable parents to encourage healthy lifestyle behaviours (PHE, 2017). Where available, families of OW and VOW children are invited to attend weight management services (WMS). However, few studies have explored whether these letters influence attendance at WMS.

### 2.4.2 Method

This single-blind, pragmatic, cluster randomised controlled trial investigates uptake of children's WMS in response to enhanced NCMP letters providing weight status feedback to parents in three English counties in 2015. Parents of 2642 OW or VOW children aged 10-11 years received an intervention or control letter informing them of their child's weight status. Intervention letters included (i) a social norms statement (see figure 4), (ii) a visual tool to help weight status recognition (see figure 5), and (iii) a pre-populated booking form for WMS for VOW children only. The primary outcome was WMS enrolment.<sup>3</sup>

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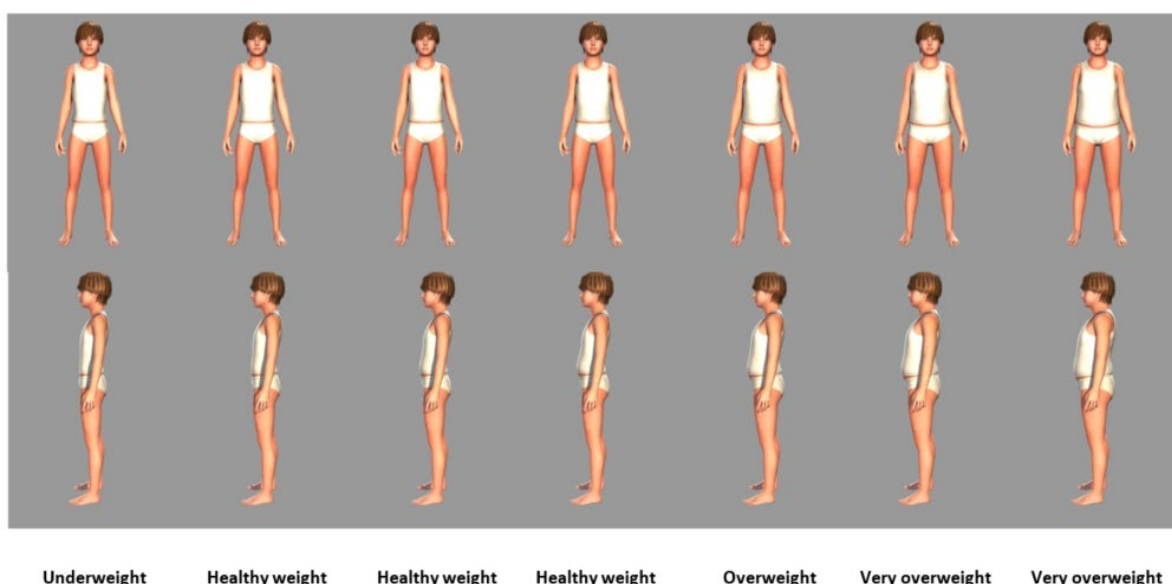
<sup>3</sup> Enrolment was the primary outcome rather than attendance because some WMS operated waiting lists where there was demand in an area of town not currently served by the WMS.

**Figure 4: Social norms feedback intervention component**

<b>«FirstName» «LastName»</b>		
<b>Height (cm) «Height»</b>	<b>Weight (kg) «Weight»</b>	<b>Weight status: Very overweight</b>
<b>«FirstName» is in the minority of local children who are overweight or very overweight. 7 out of 10 children in year 6 in Leicestershire &amp; Rutland have a healthier weight than «FirstName».</b>		

**Figure 5: Body Image Scales**

Below is the **Map Me tool** which relates to children of the same gender and age as your child. We have provided both a front and side view for each image. The small differences between the weight categories are surprising but real. The images help us to see the small changes which can happen over time and lead to children being overweight.



### 2.4.3 Summary of intervention coding

BCTs are described in the published paper. The NCMP letter aims to change health behaviour through increasing psychological capability (knowledge) using 2.6 'Biofeedback' and through improvements to social and physical opportunity by offering WMS. All COM-B components are targeted besides physical capability. Automatic motivation is targeted through prompts/cues and changes to the 'reference point' described below.

The Body Image Scales may increase salience through reframing weight feedback information pictorially as opposed to in written text. MINDSPACE provides a useful description of the intended active component of the Body Image Scales which is not found in the BCTs; altering the ‘reference point’. Economic theory suggests that decisions are made according to where we see it from – this is the reference point (Dolan, et al., 2012). The Body Image Scales aim to reset this reference point to what the norm looks like according to the local population and what is considered medically to be a healthy weight, as opposed to parents assessing their child’s weight according to those they see around them (Jones, Parkinson, Drewett, Hyland, Pearce & Adamson, 2011), potentially also overcoming confirmation bias. This is reinforced by the 6.2 ‘Social comparison’ statement in the letter.

The pre-populated booking form is described as 12.1 ‘Adding objects to the environment’, however BI would consider this a broader technique to reduce friction costs or make action simpler. Both the BCTs and BI frameworks agree that it also targets the *intention-behaviour gap* through facilitating 1.4 ‘Action Planning.’ Interventions to improve implementation intentions and overcoming the *intention-behaviour gap* generally involve ‘if-then planning’ to facilitate intentions being turned into actions (see Gollwitzer & Sheeran, 2006, for a review).

**Table 5: Study 3 Intervention coding**

Intervention component	COM-B i	BCTs ii	Intervention Function iii	MINDSPACE (plus any relevant sub-components) iv	EAST (plus any relevant sub-components) v
Overall intervention (i.e. Control condition: Provision of feedback letters about child weight category, its impact on health and information about/provision of weight management services).	Psychological capability  Physical opportunity  Reflective and automatic motivation	2.6 Biofeedback  3.2 Social support (practical)  5.1 Information about health consequences  7.1 Prompt/cue	Education  Enablement  Environmental restructuring	Salience	Timely (Prompts)
Body Image scales	Psychological capability  Automatic motivation	2.6 Biofeedback  5.1 Information about health consequences  6.2 Social comparison  13.2 Framing/reframing	Education	Incentives (Reference point)  Salience	
Social norms statement	Social opportunity  Automatic motivation	6.2 Social comparison	Environmental restructuring	Norms  Salience (Framing)	Social (Network nudge)
Pre-populated booking form ( <i>You have been reserved a place at WMS</i> ).	Psychological capability  Physical opportunity  Reflective and automatic motivation	1.4 Action planning  12.5 Adding objects to the environment	Enablement  Environmental restructuring	Commitments (Implementation intentions)	Range of practical barriers (Environment)  Easy (Friction costs, simplification)

- i. **COM-B: Capability (Physical or Psychological), Opportunity (Physical or Social), Motivation (Reflective or Automatic) – Behaviour.** See appendix 1 for definitions.
- ii. **Derived from Behaviour Change Technique Taxonomy Version 1 (Michie et al, 2013).** See appendix A, figure 14 for definitions.
- iii. **Behaviour Change Wheel Intervention Function (Education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring).** See appendix A, table 11 for definitions.
- iv. **MINDSPACE (Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, Ego) – see appendix B, table 14 for sub-components derived from the MINDSPACE map (Appendix B, figure 15).** (Dolan et al., 2010)
- v. **EAST (Easy, Attractive, Social, Timely) – see appendix B, table 15 for sub-components.** vi. See appendix C for full description of coding process

#### 2.4.4 Results

A small effect was observed, with intervention parents significantly more likely to enrol their children in weight management services (4.33%) than control parents (2.19%) in both unadjusted (OR = 2.08,  $p = .008$ ) and adjusted analyses (AOR = 2.48,  $p = .001$ ). No effects were found on self-report variables. Exploratory analyses detected no intervention effects for families of OW children (who did not receive the pre-populated booking form) but a significant increase in WMS uptake amongst intervention families of VOW children (who did receive the form).

#### 2.4.5 Discussion

The intervention letter approximately doubled enrolment at WMS compared to the national template letter in place at the time of the trial, improving adherence to NICE recommendations for OW and VOW children (NICE, 2013). Sub-group analysis indicates that the findings were mainly driven by the inclusion of the pre-populated booking form. This intervention component arguably had the most direct link with the desired behaviour (i.e. the booking form provides resources to aid WMS enrolment). However, it is impossible to disentangle the effects of this specific intervention component from the effects of child weight category – it could be, for example, that families of VOW children were more receptive to all the intervention components rather than the effect in this group being driven by the form alone. Future research should explore the unique impact of each component of this successful intervention in a factorial design.

#### 2.4.6 Policy impact

The NCMP national template letters have been amended to include a social norms statement as per the intervention letter and for VOW children a place is reserved at WMS. The guidance for local authorities recommends a registration form and FREEPOST envelope are used (PHE, 2019a). The body image scale has not been implemented as another study showed the images did not alter parental recognition but did alter BMI at 12 months (Jones et al., 2017) and this result needs to be further understood.



## 2.5 Chapter one summary

All three interventions successfully increased uptake of health interventions largely using existing intervention points and outcome measures, at low cost using experimental field trials. The use of RCTs allowed robust testing of the interventions. The importance of which is demonstrated in study 1 where the social norms message with logo reduced sign ups to the ODR compared to the control prompt.

A broad range of influences on behaviour were targeted by the interventions reflective of the combined BI and HP approach. Classically a nudge intervention would be limited to altering the physical and social context or targeting automatic motivation but it is clear that reflective motivation and psychological capability are also targeted in these interventions.

Physical opportunity was targeted, for example by providing new or easier opportunities to engage the behaviour and adding objects or prompts to the environment (i.e. new prompt to join the ODR, pre-populated booking forms for WMS). Social opportunity and automatic motivation were targeted by describing the behaviour of similar others and altering reference points for what normal weight looks like. Reflective and automatic motivation were targeted for example through provision of persuasive information and messages aimed at overcoming automatic negative emotional reactions to organ donation (i.e. the 'ick factor'). Psychological capability was targeted through provision of feedback about the consequences of behaviour (e.g. feedback on health and appearance after completing the alcohol screening questionnaire).

Interventions were delivered through four of the nine intervention types (environmental restructuring, enablement, education and persuasion). These fall into the expected spectrum of the Nuffield intervention ladder for behavioural insights interventions whereby choice is not restricted (See table 2). This is also characteristic of the focus on behaviour change through message design covered in this thesis.

Overlaps in terminology for describing the interventions can be observed between HP and BI frameworks (e.g. prompts, norms and framing). Occasionally concepts which could not be found in the HP frameworks were in the BI frameworks (e.g. hyperbolic discounting) but also exist in the psychological literature under different terminology (e.g. temporal discounting/context, Estle, Green, Myserson & Holt, 2006) raising the question of whether there are additional BCTs which could be included in the BCT taxonomy.

Behavioural insights sometimes offered finer detail to the BCTs for example 'reference points' in relation to 13.2 'Framing/reframing.' BI frameworks also enabled description of the intervention mechanisms where there were no suitable BCTs, for example 'reciprocity' for organ donation messaging and 'desire to preserve self-image' for the appearance framed alcohol messaging. Sometimes BI also offered useful overarching descriptions of intervention mechanisms such as reducing friction costs, simplification and personalisation. However, often these concepts were explanations for how we behave (e.g. a desire for fairness and reciprocity) without necessarily providing linked BCTs to overcome them, suggesting an opportunity for the BI to develop links between influences on behaviour and techniques that could be used to change them as is being developed in health psychology (e.g. Johnston et al., 2020).

## Chapter three: Increasing patient attendance at healthcare appointments

### 3.1 Study characteristics

#### 3.1.1 Target behaviours

The next three field experiments aim to increase uptake of NHS Health Checks in Medway (Study 4) and Southwark (Study 5), and attendance at outpatient appointments at Barts Hospital Trust (Study 6).

#### 3.1.2 Study methodology

Study four used quasi-randomised controlled trial methodology, study five used a factorial RCT design and study six employed two RCTs.

#### 3.1.3 Intervention context and populations

Study four involved sending amended invitation letters to all patients eligible for an NHS Health Check in 4 General Practices in the Local Authority area of Medway (3511 patients). In study five, we sent letters to all patients eligible for an NHS Health Check in 28 General Practices in the Local Authority area of Southwark (13,809 patients). Study six involved two RCTs sending Short Message Service (SMS) reminders to patients with an outpatient appointment at one of five specialisms at Barts Health NHS Trust reminding them to attend their appointment. The first RCT involved 10,111 patients and the second refined intervention messages for a further 9,848 patients.

#### 3.1.4 Outcome data

Existing sources of outcome data are used across the trials. Interventions were low cost and non-burdensome to healthcare systems and staff. The primary outcome for studies four and five was attendance at an NHS Health Check, already recorded as a READ code in patients notes in General Practice. For study six, the NHS Trust recorded a Did Not Attend (DNA) as occurring if a patient did not present at an appointment and did not cancel the appointment in advance. This data was already routinely collected.

## 3.2 Study 4: What is the effect of an enhanced invitation letter on uptake of National Health Service Health Checks?

Sallis, A., Bunten, A., Bonus, A., James, A., Chadborn, T., & Berry, D. (2016). The effectiveness of an enhanced invitation letter on uptake of National Health Service Health Checks in primary care: a pragmatic quasi-randomised controlled trial. *BMC family practice*, 17(1), 35.

### 3.2.1 Background

The National Health Service Health Check (NHS HC) is a primary prevention initiative offering cardiovascular risk assessment and management for adults aged 40–74 years. It was designed to reduce the incidence of major vascular disease events by preventing or delaying the onset of diabetes, heart and kidney disease, stroke and vascular dementia. Effectiveness of the programme was modelled on a national uptake of 75% however uptake, nationally, was 48% in the 21-month period up to the end of 2014 (Waterall, Greaves, Kearney & Fenton, 2015). Ensuring a high percentage of those offered an NHS HC receive one is key to optimising the clinical and cost effectiveness of the programme (Waterall et al., 2015).

### 3.2.2 Method

A pragmatic quasi-randomised controlled trial was conducted in four general practices in Medway, England with randomisation of 3511 patients. The aim was to compare attendance at the NHS HC using the standard national invitation letter (control – see figure 6) with an enhanced invitation letter using behavioural insights (intervention). The intervention letter (see figure 7) includes: i) simplification - reducing letter content for less effortful processing ii) behavioural instruction - action focused language iii) personal salience – ‘your appointment is due,’ rather than ‘you are invited’ and, iv) addressing implementation intentions with a tear off slip to record the date, time and location of the appointment. The primary outcome measure was attendance at an NHS Health Check.

**Figure 6: Control letter**

Dear **Xxxx**

We are inviting you to attend your free NHS Health Check.

NHS Health Checks are being offered to people aged between 40 and 74 once every five years.

The check is to assess your risk of developing heart disease, stroke, kidney disease or diabetes. If there are any warning signs, then together we can do something about it.

By taking early action, you can improve your health and prevent the onset of these conditions. There is good evidence for this.

The check should take about 20–30 minutes and is based on straightforward questions and measurements such as age, sex, family history, height, weight and blood pressure. There will also be a simple blood test to measure your cholesterol level.

Following the check, you will receive free personalised advice about what you can do to stay healthy.

Take a look at the enclosed leaflet for more information about the NHS Health Check and how it could benefit you.

Please call the surgery to book your appointment on **XXXXXXXXX**.

Yours sincerely

**Figure 7: Intervention letter**

Dear **Xxxx**

**You are due to attend your NHS Health Check.**

**Please call us on **0207 222 5555** to book your appointment and record the date and time on the slip below.**

Take a look at the enclosed information about the NHS Health Check and how it would benefit you.

Yours sincerely

Dr **XXXXXXXXXXXXX**

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Please record your appointment time and location here and stick this to the fridge

**My NHS Health Check is at \_\_\_\_\_ on \_\_\_\_\_ at \_\_\_\_\_**  
*location date time*

### 3.2.3 Summary of intervention coding

BCTs are described in the published paper. Some of the letter amendments were aimed at improvements to psychological capability by making the letter simpler and easier to understand the recommended actions as well as providing a planning prompt to help individuals to enact the behaviour once an intention is formed (reflective motivation). The planning prompt aimed to address the intention - behaviour gap.

Three BCTs were coded but two letter amendments could not be coded into BCTs. Firstly, inferring that appointments are 'due', intended as a semantic prime (Dolan, et al., 2012) and may infer attendance as the 'default' action. Neither priming or defaults are used in the BCTs. Defaults have, however been described by health psychologists as a type of 'environmental restructuring' which is an intervention function rather than a BCT (West, et al., 2019). Secondly, the shorter simpler nature of the letter. West et al., (2019) suggest an alternative way of interpreting the shorter letter using the Intervention Functions 'persuasion' and 'environmental restructuring', as it would fit their description of a 'nudge': "interventions that lead people to do things without it being obvious to them that their behaviour is being shaped. As such they can involve relatively small environmental restructuring or subtle use of language in persuasion" (West et al., 2019, p. 27).

**Table 6: Study 4 Intervention coding**

Intervention component	COM-B i	BCTs ii	Intervention Function iii	MINDSPACE – (plus any relevant sub-components) iv	EAST – (plus any relevant sub-components) v
Shorter letter	Psychological capability Automatic motivation Physical opportunity	Could not code	Environmental restructuring Persuasion Enablement	Salience	Easy (Simplification)
Behavioural instruction - action focused language	Psychological capability	4.1 Instruction on how to perform the behaviour	Enablement Education	Salience	Easy (Simplification)
Your appointment is due' rather than 'you are invited.'	Automatic motivation	Could not code	Persuasion	Priming Default	
Planning prompt (complete and stick to fridge).	Reflective motivation Physical opportunity	1.4 Action planning 7.1 Prompts/cues	Enablement Environmental restructuring	Commitment (Implementation intentions)	

- i. **COM-B: Capability (Physical or Psychological), Opportunity (Physical or Social), Motivation (Reflective or Automatic) – Behaviour. See appendix 1 for definitions.**
- ii. **Derived from Behaviour Change Technique Taxonomy Version 1 (Michie et al, 2013). See appendix A, figure 14 for definitions.**
- iii. **Behaviour Change Wheel Intervention Function (Education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring). See appendix A, table 11 for definitions.**
- iv. **MINDSPACE (Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, Ego) – see appendix B, table 14 for sub-components derived from the MINDSPACE map (Appendix B, figure 15). (Dolan et al., 2010)**
- v. **EAST (Easy, Attractive, Social, Timely) – see appendix B, table 15 for sub-components.**
- vi. **See appendix C for full description of coding process**

### 3.2.4 Results

A total of 1102 (31.4 %) individuals attended an NHS HC; 29.3 % control invitation letter versus 33.5 % intervention invitation letter, (adjusted odds ratio 1.26, 95 % confidence interval 1.09–1.47,  $p < 0.01$ ). This was an absolute difference in attendance of 4.2 percentage points for those receiving the intervention letter and a 14.3 % relative difference in attendance by the intervention group.

### 3.2.5 Discussion

Patients receiving the intervention letter were 26% more likely to attend an NHS HC appointment than patients receiving the control letter. This demonstrates that techniques to simplify information processing, increase the salience and behavioural specificity of desired actions and improve action-planning are all important for increasing uptake of the NHS HCs through letter invitations. It is not possible to know which aspect of the letter amendments was most effective, however the 4.2 % absolute difference in attendance due to the intervention letters was almost identical to the effect sizes observed in other experiments using similar interventions (Milkman, Beshears, Choi, Laibson & Madrian, 2011; Milkman Beshears, Choi, Laibson & Madrian, 2013; Nickerson & Rogers, 2010). The present research adds evidence to the impact and likely effect size of communications including planning prompts with certain characteristics (date, time and place) in prompting actions related to protective health behaviours.

### 3.2.6 Policy impact

This study was conducted in parallel with study five, a larger and more robust study. The impact of the studies together led to amendments to the national template letter for Local Authorities as described in section 3.3.6.



### 3.3 Study 5: What is the effect of pre-notification and reminder SMS with behaviourally informed invitation letters on uptake of NHS Health Checks?

Sallis, A., Sherlock, J., Bonus, A., Saei, A., Gold, N., Vlaev, I., & Chadborn, T. (2019). Pre-notification and reminder SMS text messages with behaviourally informed invitation letters to improve uptake of NHS Health Checks: a factorial randomised controlled trial. *BMC public health*, 19(1), 1162.

#### 3.3.1 Background

There is a paucity of research exploring ways to increase NHS HC uptake. Failure to recall receiving letters is reported and use of reminders may have a role for improving uptake of the NHS HC (Ellis et al., 2015). The use of SMS is emerging as an effective approach for sending reminders and is being used more often within screening and other health care programs (Free et al., 2013; Kerrison, Shukla, Cunningham, Oyeboode & Friedman, 2015; McLean et al., 2014). Alternatively, there is evidence to support some form of pre-notification, making the arrival of the invitation more salient (Cole et al., 2007; Libby et al., 2011., Van Roon et al., 2011).

#### 3.3.2 Method

This study explored the impact of behaviourally informed invitation letters and pre-notification and reminder SMS on uptake of NHS HCs. Patients at 28 General Practices in the London Borough of Southwark were included. A double-blind randomised controlled trial with a mixed 2 (pre-notification SMS – yes or no) × 4 (letter – national template control, open-ended, time-limited, social norm) × 2 (reminder SMS – yes or no) factorial design was used. The open-ended letter used simplification, behavioural instruction and a personalised planning prompt for patients to record the date and time of their NHS HC. The time-limited letter was similar but stated the NHS HC was due in a named forthcoming month. The social norms letter was like the open-ended letter but included a descriptive social norms message and testimonials from local residents and no planning prompt. The outcome measure was attendance at an NHS HC.

### 3.3.3 Summary of intervention coding

BCTs are described in the published paper. Some of the letter amendments were the same as study four (shorter, behavioural instruction, appointment due and planning prompt). However, the intervention letter variants in the present study added personalisation to the planning prompt by adding the individuals name and GP practice address where the appointment would be held. It was not possible to code this increased personalisation into the BCTs however, again, it may be considered a 'nudge' in the sense that it is a subtle change in language used for 'persuasion' (a BCW intervention function). It was also not possible to code the time limited appointment slot into BCTs. The MINDSPACE concepts of loss aversion and scarcity are relevant here (i.e. the inference that you may lose your pre-allocated appointment). Loss aversion is grounded in Prospect Theory (Kahneman & Tvesky, 1979) whereby we are thought to dislike losses more than we like equivalent gains, therefore we take more risks to avoid a loss than we would be to attain a gain. The concept of 'scarcity' suggests we are more likely to desire something which is in short supply (Dolan et al. 2010) such as appointments. Deadlines are also considered to encourage us to meet our goals (Algate et al., 2015).

The pre-notification and reminder SMS are both considered to increase psychological capability and affect physical opportunity. They may also prime patients (automatic motivation) to expect an invitation and to attend their appointment. Both are best described as 7.1 'Prompts/cues' according to BCTs and 12.5 'Adding objects to the environment.'

**Table 7: Study 5 Intervention coding**

<b>Intervention component</b>	<b>COM-B i</b>	<b>BCTs ii</b>	<b>Intervention Function iii</b>	<b>MINDSPACE – (plus any relevant sub-components) iv</b>	<b>EAST – (plus any relevant sub-components) v</b>
Shorter letter	Psychological capability Automatic motivation Physical opportunity	Could not code	Environmental restructuring Enablement	Saliency	Easy (Simplification)
Behavioural instruction - action focused language	Psychological capability	4.1 Instruction on how to perform the behaviour	Enablement Education	Saliency	Easy (Simplification)
Your appointment is due' rather than 'you are invited.'	Automatic motivation	Could not code	Persuasion	Priming Default	
Personalised planning prompt (complete and stick to fridge).	Reflective motivation Physical opportunity	1.4 Action planning 7.1 Prompts/cues	Enablement Environmental restructuring	Commitment (Implementation intention)	Timely (Prompts) Attractive (Personalise)
Time limited appointment slot (i.e. Your NHS HC is due in March)	Automatic motivation Physical opportunity	Could not code	Persuasion Environmental restructuring	Incentives (Loss aversion, scarcity effects)	Timely (Deadlines)
Social norms message and testimonials	Social opportunity	6.2 Social comparison	Environmental restructuring Modelling	Norms	
Pre-notification SMS	Psychological capability Physical opportunity Automatic motivation	7.1 Prompts/cues 12.5 Adding objects to the environment	Enablement Environmental restructuring	Priming (mental accessibility)	
Reminder SMS	Psychological capability	7.1 Prompts/cues	Enablement	Priming (mental accessibility)	Timely (Prompts)

	Physical opportunity Automatic motivation	12.5 Adding objects to the environment	Environmental restructuring		
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- i. **COM-B: Capability (Physical or Psychological), Opportunity (Physical or Social), Motivation (Reflective or Automatic) – Behaviour. See appendix 1 for definitions.**
- ii. **Derived from Behaviour Change Technique Taxonomy Version 1 (Michie et al, 2013). See appendix A, figure 14 for definitions.**
- iii. **Behaviour Change Wheel Intervention Function (Education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring). See appendix A, table 11 for definitions.**
- iv. **MINDSPACE (Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, Ego) – see appendix B, table 14 for sub-components derived from the MINDSPACE map (Appendix B, figure 15). (Dolan et al., 2010)**
- v. **EAST (Easy, Attractive, Social, Timely) – see appendix B, table 15 for sub-components.**
- vi. **See appendix C for full description of coding process**

### 3.3.4 Results

Uptake increased in almost all letter and SMS combinations compared to the control letter without SMS (Uptake 18%), with increases of up to 12 percentage points for the time-limited letter with pre-notification and reminder (Uptake 30%; Adjusted Odds Ratio AOR 1.86; 95% CI 1.45–2.83;  $p < 0.00$ ); 10 percentage points for the open-ended letter with reminder (Uptake 27%; AOR 1.68; 95% CI 1.31–2.17;  $p < 0.00$ ) and a nine percentage point increase using the time-limited letter with reminder (Uptake 27%; AOR 1.61; 95% CI 1.25–2.10;  $p < 0.00$ ). The reminder SMS increased uptake for all intervention letters. The pre-notification did not add to this effect.

### 3.3.5 Discussion

Together, the success of the open-ended letter with planning prompt in study four and the open-ended and time-limited letters with personalised planning prompts in this trial provide good evidence for the use of planning prompts in NHS HC invitation letters. Effect sizes for the two studies and previous studies using planning prompts are remarkably similar as described in section 3.2.5. To increase these effects, further planning prompts could enable specific plans to be made to overcome known barriers to attendance such as time off work to attend appointments (Burgess et al., 2015) and increasing planning specificity further with the aim of more in-depth reflective processing leading to a stronger link between plans and future actions, thereby reducing likelihood of procrastination and forgetfulness at the time of the event.

### 3.3.6 Policy impact

The time limited appointment letter with personalised planning prompt is currently (June 2020) the national template letter for NHS HC invitations: “Findings from recent behavioural insight research show that there are small, cost effective changes that have a dramatic effect on take up of the NHS Health Check. This is why we’ve changed the national letter template.” (PHE, 2019b, p. 46).

### 3.4 Study 6: Does the content of SMS reminders reduce missed hospital appointments?

Hallsworth, M., Berry, D., Sanders, M., Sallis, A., King, D., Vlaev, I., & Darzi, A. (2015). Stating appointment costs in SMS reminders reduces missed hospital appointments: findings from two randomised controlled trials. *PloS one*, 10(9), e0137306.

#### 3.4.1 Background

Missed outpatient hospital appointments were estimated to cost the NHS £225 million in 2012 to 2013 (National Audit Office, 2014). Healthcare providers are increasingly using SMS reminders to reduce 'Did Not Attend' (DNA) rates. Systematic reviews show that sending such reminders is effective, but there is no evidence on whether their impact is affected by their content (Gurol-Urganci et al., 2013; Hasvold & Woolton, 2011). Accordingly, we undertook two randomised controlled trials that tested the impact of rephrasing appointment reminders on DNA rates.

#### 3.4.2 Method

Participants were outpatients with a valid mobile telephone number and an outpatient appointment between November 2013 and January 2014 (Trial One, 10,111 participants) or March and May 2014 (Trial Two, 9,848 participants). Appointments were randomly allocated to one of four reminder messages, which were issued five days in advance. Message assignment was then compared against appointment outcomes (appointment attendance, DNA, cancellation by patient). The Trust recorded a DNA if the appointment was not cancelled in advance and the patient did not attend the appointment. SMS messages are presented in figures 8 and 9.

**Figure 8: Trial 1 messages**

**Table 1. Messages for Trial One.**

Message	Wording
<b>Control</b>	Appt at [clinic] on [date] at [time]. To cancel or rearrange call the number on your appointment letter.
<b>Easy Call</b>	Appt at [clinic] on [date] at [time]. To cancel or rearrange call 02077673200.
<b>Social Norms</b>	We are expecting you at [clinic] on [date] at [time]. 9 out of 10 people attend. Call 02077673200 if you need to cancel or rearrange.
<b>Specific Costs</b>	We are expecting you at [clinic] on [date] at [time]. Not attending costs NHS £160 approx. Call 02077673200 if you need to cancel or rearrange.

doi:10.1371/journal.pone.0137306.t001

**Figure 9: Trial 2 messages**

**Table 5. Trial Two messages.**

Message	Wording
<b>Specific Costs</b>	We are expecting you at [clinic] on [date] at [time]. Not attending costs NHS £160 approx. Call 02077673200 if you need to cancel or rearrange.
<b>General Costs</b>	We are expecting you at [clinic] on [date] at [time]. Not attending wastes NHS money. Call 02077673200 if you need to cancel or rearrange.
<b>Empathy</b>	We are expecting you at [clinic] on [date] at [time]. Please be fair to others waiting and call 02077673200 if you need to cancel or rearrange.
<b>Recording</b>	We are expecting you at [clinic] on [date] at [time]. Please attend or call 02077673200 to cancel/rearrange, or we will record as a missed appt.

doi:10.1371/journal.pone.0137306.t005

### 3.4.3 Summary of intervention coding

As discussed in study five, SMS reminders can be considered to increase psychological capability through enabling memory to attend using a prompt/cue. It is also an example of environmental restructuring, altering the physical opportunity to engage in a behaviour through adding an object (SMS) to the environment.

Sometimes the BCTs are not detailed enough to distinguish between the messages. For example, specific and general costs messages, empathy and recording messages are all under the same BCT 5.3 ‘Information about social and environmental consequences.’ BI frameworks offer a different perspective. The costs messages may relate to ego and the desire for positive self-identification. The specific costs message may be more personally salient. The ‘desire for fairness’ is a good representation of the empathy message. The ‘recording’ message could be coded in several ways through the BI frameworks although without knowing exactly how the patients interpreted the messaging it is difficult to be certain of the

mechanism of action. The intention was to provoke fear of a negative outcome but it may also have been interpreted in a way that challenged one's self-identity, compounding the spotlight effect whereby people believe their actions to be more visible than they are (Dolan, et al., 2010). Both play on the idea that the individual may not be comfortable with the hospital having a record of them as a 'non-attender' impacting on their ego. These may be more in line with automatic processes.



**Table 8: Study 6 Intervention coding**

Intervention component	COM-B i	BCTs ii	Intervention Function iii	MINDSPACE – (plus any relevant sub-components) iv	EAST – (plus any relevant sub-components) v
Overall intervention (i.e. SMS appointment reminder)	Psychological capability  Physical opportunity	7.1 Prompts/ cues  12.5 Adding objects to the environment	Enablement  Environmental restructuring		Timely (Prompts)
Easy call	Physical opportunity	12.5 Adding objects to the environment	Environmental restructuring	Salience	Easy (Friction costs, simplification)
Social norms	Social opportunity	6.2 Social comparison	Environmental restructuring	Norms	Descriptive norm (social)
Specific costs	Reflective motivation	5.3 Information about social and environmental consequences	Persuasion	Ego (Positive self-identification)  Salience	
General costs	Reflective motivation	5.3 Information about social and environmental consequences	Persuasion	Ego (Positive self-identification)	
Empathy	Reflective motivation  Social opportunity	5.3 Information about social and environmental consequences	Persuasion  Environmental restructuring	Ego (desire for fairness)	
Recording	Reflective and automatic motivation	5.3 Information about social and environmental consequences	Persuasion	Messenger  Ego (desire to preserve self-image, spotlight effect)  Norms (Fear of loss of face)	

- i. **COM-B: Capability (Physical or Psychological), Opportunity (Physical or Social), Motivation (Reflective or Automatic) – Behaviour.** See appendix 1 for definitions.
- ii. **Derived from Behaviour Change Technique Taxonomy Version 1 (Michie et al, 2013).** See appendix A, figure 14 for definitions.
- iii. **Behaviour Change Wheel Intervention Function (Education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring).** See appendix A, table 11 for definitions.
- iv. **MINDSPACE (Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, Ego) – see appendix B, table 14 for sub-components derived from the MINDSPACE map (Appendix B, figure 15).** (Dolan et al., 2010)
- v. **EAST (Easy, Attractive, Social, Timely) – see appendix B, table 15 for sub-components. Vi See appendix C for full description of coding process**

### 3.4.4 Results

In trial one, a message including the specific cost of a missed appointment to the health system produced a DNA rate of 8.4%, compared to 11.1% for the existing (control) message (OR 0.74, 95% CI 0.61–0.89,  $P < 0.05$ ). Trial two replicated this effect (DNA rate 8.2%), but also found that expressing the same concept in general terms was significantly less effective (DNA rate 9.9%, OR 1.22, 95% CI 1.00–1.48,  $P < 0.05$ ).

### 3.4.5 Discussion

The results show that presenting the specific cost of the appointment produces a DNA rate that is approximately three percentage points lower than for other messages, a result that is replicated. Moving from the existing reminder to the more effective costs message would result in 5,800 fewer missed appointments per year in the NHS Trust in question, at no additional cost.

### 3.4.6 Policy impact

The hospital trust implemented the most effective message. Although there is no official data the study is well known in the NHS possibly due to media coverage<sup>4</sup> and anecdotally many people have received the same costs message from multiple NHS providers. A similar study was undertaken in Israel (Berliner Senderey et al., 2020) and found that an almost identical ‘specific costs’ message also reduced DNA rates.

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<sup>4</sup> <https://www.theguardian.com/healthcare-network/2015/nov/18/nhs-great-communication-healthcare-save-lives-behavioural-insight-nudge>  
<https://www.gov.uk/government/publications/reducing-missed-hospital-appointments-using-text-messages/a-zero-cost-way-to-reduce-missed-hospital-appointments>

### 3.5 Chapter three summary

All interventions had positive impacts on the outcome measures using existing processes and outcome measures at low or no cost and used randomised (or quasi-randomised) trial methodology. Again, study samples were large. Effect sizes were consistent with or larger than similar studies.

All COM-B domains were targeted except physical capability. Physical opportunity was addressed using prompts and appointment reminders including planning prompts (also addressing reflective motivation through implementation intentions). Social opportunity was addressed through social norms messaging about attendance at appointments using BCTs such as 6.2 'Social Comparison'. Psychological capability was targeted through BCTs such as 4.1 'Instruction on how to perform behaviour'. Automatic motivation was addressed through changes to language indicating that appointments are due and through SMS content potentially challenging individuals ego and self-identity (e.g. the hospital will record DNAs). Sometimes COM-B coding was difficult as the mechanism of action through which the intervention worked depends upon the participants interpretation of the content. Interventions were delivered through the same four intervention types as the previous chapter (environmental restructuring, enablement, education and persuasion).

Behavioural Insights again offered some useful overarching descriptors such as simplification and personalisation. There was overlap between BI and HP frameworks in similar areas to the previous studies (e.g. prompts, framing, implementation intentions). Where no appropriate BCTs could be identified BI offered some potential descriptions of the mechanisms of action and techniques employed such as scarcity and deadlines for the time-limited appointment slots.

Study five provides a good example of using the Test, Learn, Adapt approach (Haynes et al., 2012) which is the gold standard for behavioural insights. This study used two RCTs using the most effective message in the first trial as the control

message for the second trial to determine if adapting the message could provide further improvements.

It is difficult to claim generalisability of the trials beyond the contexts within which they were tested as they were not nationally representative samples and the NHS HC studies showed large variations in effectiveness across practices. However, it would be worth other practices and hospitals testing these interventions and observing the effects, especially if the characteristics of their local populations and contexts are similar.

## **Chapter four: Reducing inappropriate antibiotic prescribing in General Practice.**

### **4.1 Study characteristics**

#### **4.1.1 Target behaviours**

The target behaviour for the final two studies is to reduce antibiotic prescribing in primary care.

#### **4.1.2 Study methodology**

Study seven used a randomised 2 x 2 factorial design. Study eight is a cluster randomised controlled trial.

#### **4.1.3 Intervention context and populations**

Both studies introduced new intervention points. Study seven involved all GP Practices in England who were in the top 20% of antibiotic prescribers (n = 1581). Study eight recruited 209 General Practices from 29 clinical commissioning groups across England. Clusters of practices were randomised to a business as usual control group or one of two intervention groups; a personalised commitment to prudent antibiotic prescribing displayed as a poster in GP consulting rooms or, the same poster plus an antimicrobial stewardship message played to patients on telephone appointment booking lines.

#### **4.1.4 Outcome data**

Data were extracted from a national administrative ePACT database. This covers NHS prescriptions written in England which have been dispensed in the UK. Aggregate data for each month are collected at practice level only and not available for individual prescribers; indication for antibiotic therapy is not recorded. This data was accessed by the study team without the need for practices to facilitate.

## 4.2 Study 7: Does social norms feedback to high prescribers reduce antibiotic prescribing?

Hallsworth, M., Chadborn, T., Sallis, A., Sanders, M., Berry, D., Greaves, F., ... & Davies, S. C. (2016). Provision of social norm feedback to high prescribers of antibiotics in general practice: a pragmatic national randomised controlled trial. *The Lancet*, 387(10029), 1743-1752.

### 4.2.1 Background

Unnecessary antibiotic prescribing contributes to antimicrobial resistance. An important driver of resistance is the use of antibiotics when they are not clinically indicated (Harbarth & Samore, 2005). Primary care accounts for a large proportion of antibiotic prescriptions (ESPAUR, 2018) and its prescribing practices have been linked to increased antimicrobial resistance (Smieszek et al., 2018).

### 4.2.2 Method

In this randomised 2 × 2 factorial trial, publicly available databases were used to identify GP practices whose prescribing rate for antibiotics was in the top 20% for their NHS Local Area Team. Eligible practices were randomly assigned into two groups, stratified by NHS Local Area Team. On Sept 29, 2014, every GP in the feedback intervention group was sent a letter from England's Chief Medical Officer (see figure 10) and a leaflet on antibiotics for use with patients. The letter stated that the practice was prescribing antibiotics at a higher rate than 80% of practices in its NHS Local Area Team. GPs in the control group received no communication.

The sample was re-randomised into two groups, and in December 2014, GP practices were either sent patient-focused marketing information that promoted reduced use of antibiotics or received no communication.

The primary outcome measure was the rate of antibiotic items dispensed per 1000 weighted population, controlling for past prescribing.

Figure 10: Study 7 Intervention letter

**NOTE TO PRACTICE MANAGERS: PLEASE FORWARD IMMEDIATELY TO GP ADDRESSED**

Dear Dr [GP\_Surname]

**Antibiotic usage in your practice**

Antimicrobial resistance is a serious and growing threat to our health. Reducing unnecessary prescriptions in primary care may help prevent a public health catastrophe.

**The great majority (80%) of practices in [NHS Area Team] prescribe fewer antibiotics per head than yours.\***

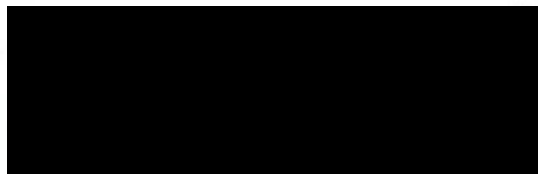
Many practices are already taking action to reduce antibiotic prescriptions while safeguarding patients' health. Please join them by taking three simple actions:

1. Give patients advice on self-care instead – you can use the leaflet enclosed or search online for the "TARGET antibiotics toolkit".
2. Consider offering a back-up (delayed) prescription instead – this could be post-dated or collected by the patient a few days later if still necessary.
3. Talk to other prescribers in your practice to ensure they are also acting – data on prescribing is recorded at practice level.

I know that prescribers are aware of this problem and that prescribing is not a simple issue. But there are small changes we can all make that will have a big effect on everyone's health.

Please join us in reducing antibiotic use.

Yours,



**PROFESSOR DAME SALLY C DAVIES  
CHIEF MEDICAL OFFICER**

#### 4.2.3 Summary of intervention coding

BCTs are described in the published paper. The letter largely targets psychological capability, reflective motivation, social and physical opportunity – a broad range for one intervention accounted for by the inclusion of a self-care/no prescription leaflet, suggestions for delayed prescribing and collaboration with colleagues. Subsequently a broader range of BCTs are also delivered in this intervention compared to other letter interventions reported in this thesis.

There is significant overlap between the BCTs and BI frameworks around social norms, salience, feedback, substitution and messenger. The network nudge (EAST) is a useful addition to the intervention description as it helps to elaborate on the intervention component aimed at getting prescribers to talk to each other and influence each other's prescribing.

The letter contains phrases like 'please join them', 'please join us' intended to promote collective action. EAST includes the relevant concept of 'diffusion of responsibility' whereby others are less likely to take responsibility for action or inaction when there are bystanders. The bystander effect is a concept well known in psychology (Darley & Latane, 1968; Latane & Darley, 1969) but not represented in BCTs or the Theoretical Domains Framework. Proposing that the practice hold prescribing meetings to discuss the actions proposed is a way of gaining cooperation amongst all prescribers since prescribing is recorded at practice level.



**Table 9: Study 7 Intervention coding**

<b>Intervention component</b>	<b>COM-B i</b>	<b>BCTs ii</b>	<b>Intervention Function iii</b>	<b>MINDSPACE – (plus any relevant sub-components) iv</b>	<b>EAST – (plus any relevant sub-components) v</b>
"Antimicrobial resistance is a serious and growing threat to our health."	Reflective and automatic motivation	5.1 Information about health consequences	Education Persuasion	Salience	
"Reducing unnecessary prescriptions in primary care may help prevent a public health catastrophe"	Reflective and automatic motivation	5.2 Salience of consequences 5.3 Information about social and environmental consequences	Persuasion	Salience	
"The great majority (80%) of practices in X area prescribe fewer antibiotics than yours..."  "Many practices are already taking action..."	Social opportunity	6.2 Social comparison 2.2 Feedback on behaviour	Environmental restructuring	Norms	Social (network nudge, feedback, relative ranking)
"Please join them by taking three simple actions"	Psychological capability Social opportunity	4.1 Instruction on how to perform a behaviour	Education Persuasion	Ego (self-efficacy) Norms (In group/out group effects, social proof/herd behaviour)	Easy (Simplification) Social (people helping people)
"Give patients advice on self-care – you can use the leaflet enclosed. "	Psychological capability Physical opportunity	8.2 Behaviour substitution 12.5 Adding objects to the environment	Enablement Environmental restructuring	Environment (Resources)	Easy (Substitution)
"Consider offering a back-up (delayed) prescription instead"	Psychological capability Physical opportunity	8.2 Behaviour substitution 12.5 Adding objects to the environment	Enablement Environmental restructuring		Easy (Substitution)
"Talk to other prescribers in your practice to ensure they are also	Reflective motivation	5.3 Information about social and environmental consequences	Persuasion	Norms (Social influence, diffusion of responsibility)	

acting – data on prescribing is recorded at practice level"	Social opportunity	2.5 Monitoring outcomes of behaviour by others without feedback. ( <i>inferred</i> )  3.1 Social support unspecified	Environmental restructuring		
"Yours Professor Dame Sally C Davies"	Reflective and automatic motivation  Social opportunity	9.1 Credible source	Persuasion  Environmental restructuring	Messenger (formal authority)	

- i. **COM-B: Capability (Physical or Psychological), Opportunity (Physical or Social), Motivation (Reflective or Automatic) – Behaviour. See appendix 1 for definitions.**
- ii. **Derived from Behaviour Change Technique Taxonomy Version 1 (Michie et al, 2013). See appendix A, figure 14 for definitions.**
- iii. **Behaviour Change Wheel Intervention Function (Education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring). See appendix A, table 11 for definitions.**
- iv. **MINDSPACE (Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, Ego) – see appendix B, table 14 for sub-components derived from the MINDSPACE map (Appendix B, figure 15). (Dolan et al., 2010)**
- v. **EAST (Easy, Attractive, Social, Timely) – see appendix B, table 15 for sub-components.**
- vi. **See appendix C for full description of coding process**

#### 4.2.4 Results

Between September 8 and September 26, 2014, we recruited and assigned 1581 GP practices to feedback intervention (n=791) or control (n=790) groups. Letters were sent to 3227 GPs in the intervention group. Between October, 2014, and March, 2015, the rate of antibiotic items dispensed per 1000 population was 126·98 (95% CI 125·68–128·27) in the feedback intervention group and 131·25 (130·33–132·16) in the control group, a difference of 4·27 (3·3%; incidence rate ratio [IRR] 0·967 [95% CI 0·957–0·977];  $p < 0.0001$ ), representing an estimated 73, 406 fewer antibiotic items dispensed.

In December 2014, GP practices were re-assigned to the patient focused intervention (n=777) or control (n=804) groups. The patient focused marketing intervention did not significantly affect the primary outcome measures between December 2014 and March 2015.

#### 4.2.5 Discussion

Social norms feedback from a high-profile messenger can substantially reduce antibiotic prescribing at low cost and at national scale. Marketing materials aimed at patients did not affect prescribing, the cost of which is far greater.

#### 4.2.6 Policy impact

England's Chief Medical Officer has written to GPs using this approach and variants of it every year since this trial (e.g. Ratajczak, Gold Hailstone & Chadborn, 2019). The intervention has been implemented by Chief Medical Officers in Northern Ireland (Bradley, Allen, Quinn, Bradley & Dokan, 2019; Public Health Agency, 2017), Australia (Australian Government, 2018) and Canada (Government of Canada, 2019; Ontario Agency for Health Protection and Promotion, 2019) with France planning to join them (Behavioural Insights Team and UK Science & Innovation Network in France, 2019). The author of this thesis was interviewed about the research in *The Psychologist* in 2016 and followed up in 2019 about this work and other work on antimicrobial resistance (Sallis, 2016).

### 4.3 Study 8: Can prescriber commitment posters and antimicrobial stewardship messages to patients reduce antibiotic prescribing?

Sallis, A., Bondaronek, P., Sanders, J. G., Yu, L. M., Harris, V., Vlaev, I., ... & Chadborn, T. (2020). Prescriber Commitment Posters to Increase Prudent Antibiotic Prescribing in English General Practice: A Cluster Randomized Controlled Trial. *Antibiotics*, 9(8), 490. doi:10.3390/antibiotics9080490

#### 4.3.1 Background

Unnecessary antibiotic prescribing contributes to Antimicrobial Resistance posing a major public health risk. Estimates suggest as many as half of antibiotics prescribed for respiratory infections may be unnecessary (Fleming-Dutra et al., 2016; Smieszek et al., 2018). This study aimed to replicate a commitment poster intervention shown to be effective at reducing prescribing in California (Meeker et al., 2014).

#### 4.3.2 Method

Prescribers from 42 Clinical Commissioning Groups (CCGs) were invited to participate in a three-armed unblinded cluster RCT conducted from February to July 2016. Interventions were a commitment poster advocating safe antibiotic prescribing (see figure 11), or a commitment poster plus an antimicrobial stewardship message on telephone appointment booking lines stating:

*“GPs in this practice do not prescribe antibiotics for infections which usually get better on their own such as colds and flu. Please visit your pharmacist for advice.”*

The primary outcome measure was antibiotic item dispensing rates, per 1000 population adjusted for practice demographics. The outcome measures for post-hoc analysis were dispensing rates of antibiotics usually prescribed for upper respiratory tract infections and broad-spectrum antibiotics. A process evaluation is reported separately. <sup>5</sup>

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<sup>5</sup> See author bibliography revise and resubmit section for: Tonkin-Crine, S., Schneider, A., Herd, N., Michie, S., Butler, C., Chadborn, T. & Sallis, A. (Revise and resubmit) Implementing practice-level nudge interventions to encourage prudent antibiotic prescribing in general practice: a mixed-methods process evaluation. *Antibiotics*

Figure 11: Commitment poster



#### 4.3.3 Summary of intervention coding

Both interventions use environmental restructuring – one targeted at patients, the other at prescribers. They aim to change the physical opportunity to engage in the behaviour by interrupting appointment bookings which may lead to antibiotic prescribing or by providing a visual prompt to prescribers of their prior commitments (i.e. poster displayed in consulting rooms). An alternative behaviour is offered to patients 8.2 'Behaviour substitution' for responding to symptoms, (i.e. visit the pharmacy) which may be targeting social opportunity by providing social support. Both interventions target psychological capability, aiming to increase knowledge, for prescribers via the pledge acronym and providing instructions on how to appropriately prescribe antibiotics and for patients via the answerphone message. The prescriber interventions also target reflective motivation through an active commitment to appropriate prescribing. For patients their social opportunity to

engage in the behaviour is shaped by information about prescriber's likely response to appointments where antibiotics are expected for self-limiting illness and through the credibility of the messenger as the message is delivered via the practice answerphone.

Additionally, the answerphone message intervention may work as an attempt to convey a change in default – to attend the pharmacy before booking an appointment for self-limiting illnesses. Self-identity, self-image and loss of face are also used to describe elements of the prescriber intervention which were not overtly identified in the BCTs despite identity being mentioned in the Theoretical Domains Framework.

**Table 10: Study 8 Intervention coding**

Intervention component	COM-B i	BCTs ii	Intervention Function iii	MINDSPACE – (plus any relevant sub-components) iv	EAST – (plus any relevant sub-components) v
<b><u>Commitment poster displayed in consulting room</u></b>  The primary target for the commitment poster is prescribers. Only prescriber directed BCTs are coded.	Physical opportunity	7.1 Prompts/cues  12.1 Adding objects to the environment	Environmental restructuring		Timely (Prompts)
<b>Individual commitment:</b> Active process of reading, signing and adding photo to poster and the commitment banner itself – stating: ‘I am committed to safe antibiotic prescribing to protect our patients’ health.’  <b>Practice commitment:</b> “We are committed to combating drug resistant infections to protect your health and well-being. We will only prescribe antibiotics when it is the appropriate and necessary treatment. We do not prescribe antibiotics for colds and other self-limiting infections.”	Reflective motivation  Social opportunity	1.9 Commitment  3.1 Social support (unspecified)	Persuasion  Environmental restructuring	Commitment  Norms (social influence)	
AMS message in letter from GP to patient (main body of text)	Reflective motivation	5.1 Information about health consequences  5.2 Salience of consequences  5.3 Information about social and environmental consequences	Persuasion	Salience	
Poster side of the commitment:  ‘Antibiotic prescribing – proceed with caution! Poor prescribing puts patients at increased risk of drug resistant infections.’	Reflective motivation	5.1 Information about health consequences  5.3 Information about social and environmental consequences	Persuasion	Salience	

PLEDGE acronym	Psychological capability	4.1 Instruction on how to perform the behaviour	Education	Priming	Easy (Simplification)
<b><u>Automated message</u></b>  The primary target for the automated message is patients and only patient directed BCTs are coded. We expect the intervention to impact upon antibiotic prescribing through fewer patient consultations for self-limiting RTIs.	Physical opportunity	12.1 Restructuring the physical environment	Environmental restructuring	Messenger	Timely (Prompts)
<i>"GPs in this practice do not prescribe antibiotics for infections which usually get better on their own such as colds and flu. Please visit your pharmacist for advice."</i>	Psychological capability  Social opportunity	3.2 Social support (practical)  4.1 Instruction on how to perform the behaviour  6.3 Information about others approval  8.2 Behaviour substitution  9.1 Credible source	Education  Environmental restructuring	Messenger  Default	Easy (substitution)

- i. **COM-B: Capability (Physical or Psychological), Opportunity (Physical or Social), Motivation (Reflective or Automatic) – Behaviour.** See appendix 1 for definitions.
- ii. **Derived from Behaviour Change Technique Taxonomy Version 1 (Michie et al, 2013).** See appendix A, figure 14 for definitions.
- iii. **Behaviour Change Wheel Intervention Function (Education, persuasion, incentivisation, coercion, training, enablement, modelling, environmental restructuring).** See appendix A, table 11 for definitions.
- iv. **MINDSPACE (Messenger, Incentives, Norms, Defaults, Salience, Priming, Affect, Commitments, Ego) – see appendix B, table 14 for sub-components derived from the MINDSPACE map (Appendix B, figure 15). (Dolan et al., 2010)**
- v. **EAST (Easy, Attractive, Social, Timely) – see appendix B, table 15 for sub-components.**
- vi. **See appendix C for full description of coding process**



#### 4.3.4 Results

209 practices across 29 CCGs participated. 17 were grouped into three units due to co-located prescribers or shared consulting rooms leaving 196 practice units randomised to usual care (n = 60), Commitment Poster (n = 66) and Commitment Poster and Answerphone Message (n=70). There was no effect on overall dispensing rates for either interventions compared to usual care (Commitment Poster 5.673, 95% CI -9.768 to 21.113,  $P=0.458$ ), (Commitment Poster and Answerphone Message, -12.575, 95% CI -30.726 to 5.576,  $P = 0.167$ ). Secondary analysis, showed a significant effect of the Answerphone Message (-18.444, 95% CI -32.596 to -4.292,  $P=0.012$ ). Fewer penicillins and macrolides were prescribed in the Commitment Poster and Answerphone Message intervention compared to usual care (-12.996, 95% CI -34.585 to -4.913,  $P= 0.018$ ).

#### 4.3.5 Discussion

Commitment posters did not reduce antibiotic prescribing. Whilst many of the reported barriers to prudent antibiotic prescribing are similar in England and the US, one important difference is consultation length, with a norm of 10 minutes in England compared to 20 minutes in the US. It is possible that, despite the good intentions and commitments, UK prescribers were unable to enact their commitments due to competing demands during the consultation and pressures of workload as has frequently been cited by UK GPs (Rodrigues, Roque, Falcao, Figuerias & Heiderio, 2013; Tonkin-Crine, Yardley & Little, 2011). Short consultation length has previously been associated with overuse of antibiotics (Chattopadhyay et al., 2013; Jin et al., 2015; Nizami, Khan & Bhutta, 1996). The intervention also lacked any kind of if-then plan to enable prescribers to overcome the intention-behaviour gap used in studies four and five for example.

An automated patient antimicrobial stewardship message showed some effect and requires further testing. The automated message directly addressed patient's expectations regarding antibiotic prescribing for colds and flu. Reduced prescribing may have been due to patients seeking pharmacy advice instead of booking a consultation although such a conclusion would require different outcomes measures.

#### 4.3.6 Policy impact

Due to the mixed results further research is required before policy recommendations can be made. The process evaluation provides further elaboration.<sup>6</sup>

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<sup>6</sup> See footnote five.

## 4.4 Chapter four summary

Study seven statistically and clinically significantly reduced antibiotic prescribing. Study eight did not impact upon the main outcome measure of overall reduced antibiotic prescribing, but secondary analysis suggests that the answerphone message facilitated a reduction in prescribing of antibiotics usually prescribed for the self-limiting illnesses targeted in the intervention messaging. The outcome measures for both studies used nationally available dispensing data so there was no data collection burden on general practices.

The interventions targeted all COM-B domains besides physical capability. Interventions were delivered through education, persuasion, environmental restructuring.

Like the previous studies the interventions focused on providing messages to change behaviour. Study eight differs to the other studies as more active participation was expected from prescribers who were required to read and sign the personalised posters and commit to its content. Despite its active content, this was the only intervention not to yield significant results on the main outcome measure. It is perhaps the case that other interventions in this thesis and in this chapter facilitated change through providing other solutions to overcome barriers, for example study seven included a leaflet which can be used to provide self-care advice or given to patients alongside a delayed prescription (i.e. offering a substitute behaviour instead of antibiotic prescribing). Whereas study eight did not offer prescribers any solutions to overcome barriers to good intentions and implement their prior commitment. The potentially effective automated phone message in study eight also included behavioural substitution in that it proposed attending the pharmacy instead of booking an appointment.

The results of the process evaluation for study (see footnote five) which involved interviews and surveys with participating prescribers and practice staff revealed that the commitment process was not as active as intended. Sometimes prescribers directed practice staff to send pre-existing signatures and photographs to the

researchers to be added to the commitment posters – it is therefore unclear whether some prescribers even read the posters content and could not therefore have committed to prescribing according to its contents. Intervention fidelity was measured in the trial and was described as high for both implementing the answerphone message and displaying the posters, but it appears the fidelity checks did not identify whether the active ingredients of the intervention were implemented (i.e. the prescriber actively committing to the actions in the poster). The importance of fidelity checks and process evaluation is apparent here.

BI coding demonstrated substantial overlaps with the BCTs but did offer some relevant additional insights such as ‘network nudge’.

In terms of generalisability, study seven was applied to the entire sampling population and therefore the impact was observed in the national data. Although drawn from across the country, the sample for study eight relied upon willing practices and prescribers and this may have impacted the robustness and generalisability of results.

## Chapter five: Discussion

In this thesis, eight trials were presented and described according to behavioural insights frameworks, the Behaviour Change Wheel and Behaviour Change Technique Taxonomy Version 1. The process of conducting these studies and coding the interventions facilitates consideration of the following research question:

**Can behavioural insights frameworks optimise the application of health psychology tools and frameworks to behaviour change intervention design in a policy context? If so, how?**

### 5.1 Theoretical implications

This section argues that the answer to the research question is yes and ideas for how BI frameworks can be used to enhance HP frameworks are given. Limitations to the BI frameworks are also discussed.

Whilst the BI approach to intervention design has popularised a language of nudges, choice architecture, heuristics and cognitive biases, health psychologists have called for a standardisation of terminology for describing interventions partly to enable replication and inclusion of papers in systematic reviews (Michie et al, 2013a). The two sets of terminology can lead to confusion both in the literature and amongst behaviour change practitioners in government trying to decide which frameworks, techniques and terminology to apply in the design of their interventions.

Five of the eight interventions presented in this thesis are described using BCTs in the published papers. None of the published papers used BI frameworks in their intervention descriptions. This was due to the wider acceptability in the academic psychology press of the BCW compared to MINDSPACE, desire to adhere to requests to standardise terminology and because MINDSPACE does not explicitly offer behaviour change techniques, rather it describes general influences on behaviour, some of which can be translated into techniques to change behaviour.

Across the interventions, all aspects of the overarching acronyms for MINDSPACE were coded in this thesis as would be expected given these trials were largely conducted from a behavioural insights perspective.

The COM-B coding showed a broad range of influences on behaviour were targeted by the interventions but using a limited number of intervention types (i.e. environmental restructuring, education, persuasion, enablement, and one instance of modelling) which accord with the 'softer' end of Nuffield ladder interventions descriptions (preserving and enabling choice) and interventions aims to change behaviour through message design.

Coding each of the interventions into both frameworks through this thesis has facilitated the following observations:

1. Terminology sometimes overlapped between the BI and HP frameworks (e.g. Prompts, norms, framing). Where overlaps occur, it is potentially better to use the more widely academically published and scientifically grounded terminology drawn from HP frameworks.
2. Each BI concept is described in terms of its theoretical origins (Dolan et al., 2012) and suggestions for how to change behaviour considering this are proposed. However, the BI concepts do not link an understanding of behaviour (i.e. mechanism of action) to techniques to change behaviour in a structured way. BI specialists could attempt a more structured way of linking influences on behaviour to techniques to change it.
3. BI concepts sometimes offered finer detail to intervention descriptions helping to differentiate between different intervention techniques applied, for example those around the concept of ego and the desire to preserve self-image, reference points, scarcity, defaults, reciprocity, network nudges, deadlines and hyperbolic discounting although there is some muddling of influences on behaviour and behaviour change techniques amongst these. Sometimes these concepts are readily available in the psychological literature but under different terminology for example hyperbolic discounting and temporal discounting (Story, Vlaev, Seymour, Darzi & Dolan, 2014) but are not captured in health psychology tools describing potential influences on behaviour (i.e. the Theoretical Domains Framework) or BCTs to address them. This suggests that exploring the relevance of BI concepts and the wider behavioural economics and psychology literature to HP frameworks may

provide additional understanding of the influences on behaviour and yield additional BCTs.

4. BI concepts sometimes offered broader descriptions and techniques absent from the HP frameworks such methods to overcome friction costs, simplification and methods to increase relevance of messaging such as personalisation. Some of these more generic concepts are captured in other HP frameworks for example tailoring and facilitation are methods described in the Intervention Mapping taxonomy (Kok et al., 2016).

One explanation for the gaps in the BCTs identified here is that the BCT taxonomy was developed by retrospectively coding health behaviour change interventions aimed at changing specific behaviours (e.g. healthy eating, physical activity, smoking cessation) published prior to 2012. This was a time when many health psychology interventions were theoretically grounded in social cognitive models of behaviour, many of which do not account for the more automatic processes involved in habitual behaviour, emotions, impulsivity and associative learning (Dixon & Johnston, 2020). The grounding of the interventions making up the BCT-T V1, in models biased towards reflective processes (Bull et al., 2018; Michie, Abraham, Whittington McAteer & Gupta, 2009a), means that relatively few BCTs are included which are aimed at changing behaviour through automatic processes as is evidenced by a recent exercise coding BCTs to categories representing reflective and automatic processes (Dixon & Johnston, 2020). Only nine of the 93 BCTs were reliably coded by experts into the category representing automatic processes, with the rest coded into categories described as reflective.

Although the Theoretical Domains Framework does consider cognitive, affective, social and environmental influences on behaviour (Atkins et al., 2017), it can also be seen from work mapping the COM-B domains to TDF domains that domains most likely to be considered behavioural insights (i.e. automatic motivation, physical and social opportunity) include the fewest TDF domains. For example, automatic motivation contains only two TDF domains (reinforcement and emotion) compared to reflective motivation which includes six domains. Psychological capability contains four domains, whilst physical and social opportunity each contain only one domain

(Michie, Atkins & West, 2014, p. 113). The new Theory and Techniques Tool (TaTT) has extended the mechanisms of action previously included in the TDF from 14 to 25 (Carey et al., 2019) and these may offer further substance to the social opportunity (e.g. norms, subjective norms), automatic motivation (e.g. needs, values) and physical opportunity (e.g. behavioural cueing) domains of COM-B. However, the development of the TaTT used only 77 BCTs drawn from the existing BCT taxonomy.

Whilst, the COM-B model does explicitly include areas such as physical opportunity, automatic motivation and social opportunity which better represent the concepts drawn from BI, an updated BCT taxonomy is required to identify more techniques to target these COM-B domains. However, if the next version of the BCT taxonomy relies on identification of techniques already applied in the literature, and if intervention designers have all been using the BCT-T V1 to code and design their interventions, any new taxonomy would be restricted to finding only BCTs already in the BCT-T V1. This would limit our ability to identify new, potentially relevant and effective BCTs for an updated taxonomy. Ogden, (2016) has criticised the BCW and systematising theory in general as potentially limiting the development of new ideas and theory and suggests that ‘their attempt at synthesis was premature and focused on the wrong data (Ogden, 2016, p. 276). Others support variation in theory selection and testing suggesting the field of health psychology should allow its practitioners ‘to test whatever mechanisms and whatever theories they see as most fruitful’ (Texeria., 2016, p. 271). It would seem an important omission from any future BCT taxonomy development if trials originating from behavioural economics and BI approaches were not explicitly sought out for inclusion given their demonstrated successful application to health behaviour change.

It is also important to note that many of the interventions making up the BCT-T V1 would have been delivered face to face, in groups or to individuals, over several weeks or months by specially trained professionals. This contrasts with the BI approach used here in which interventions were delivered at distance either through letters or websites and without requiring resource intensive activity on the part of the practitioner, again leaving room for other BCTs to be relevant. The post-hoc nature



of the BCT taxonomy development and its reliance on potentially poorly designed and reported interventions has been noted previously, (Texira, 2016) as has the need for prospective tools for intervention design; “there needs to be an ante-hoc process that informs the building of the intervention in the first place” (Michie et al., 2009a, ‘The relationship between post-hoc and ante-hoc description’ sub-section), and the need to expand the scope of BCTs to cover intervention modes more relevant to policy level interventions; “Further work needs to be done to extend it to the BCTs relevant to community and population level interventions (Michie et al., 2013a, ‘Future Developments’ section).

## 5.2 Beyond the randomised controlled trial: Strategic Behavioural Analyses in policy.

The trials presented had an impact on the intended outcomes, but isolated trials alone are not going to solve the complex health issues being targeted. The BI frameworks (i.e. MINDSPACE, EAST and Test, Learn, Adapt) do not give much advice on how to select the right target group and behaviour and are often opportunistic and sometimes target only the low hanging fruit. For example, we now know that whilst increasing the number of people on the organ donation register was welcomed, without an accompanying intervention to ensure loved ones’ respect these wishes, often the outcome of organ donation itself was not being realised (Pieri & Metcalfe, 2020). In 2020, in England, new legislation (*Organ Donation Deemed Consent Act, 2019*) was introduced making organ donation ‘opt out’ rather than ‘opt in,’ restricting choice and changing the default. However, it is still possible for the family to override the deceased wishes (Pieri & Metcalfe, 2020) so it remains to be seen whether this intervention succeeds, but it does highlight the importance of selecting an appropriate target behaviour and considering all the relevant intervention functions available to target it. The nudge approach has been criticised previously for failing to consider the full range of intervention options available, for example excluding legislation, regulation and service provision (Michie & West, 2012).

To ensure all the relevant policy options are considered, several ‘strategic behavioural analyses’ (SBA) have been conducted across a range of policy areas (e.g. Atkins et al., 2020a; Atkins et al., 2020b; Lawrenson et al., 2018; Pinder, Sallis,

Berry & Chadborn, 2015; Wanat et al., 2020) with more publications under review (see author bibliography 'revise and resubmit'). Strategic Behavioural Analyses are a new method using the BCW and related frameworks to determine whether existing policy interventions in a specified area are addressing the appropriate target behaviours and behavioural determinants, using the appropriate BCTs, intervention functions and policy options. It allows gaps and opportunities to be identified for new and refined interventions and policies. This methodology allows a wider systems approach to understanding the full policy context before offering solutions. Other systems approaches are useful for understanding the full context and inter-dependencies between behaviour and identifying suitable behavioural targets (Peters, 2014).

Behavioural scientists have a wider remit to advise policy as has been seen during the 2020 COVID 19 pandemic for example through the BPS COVID 19 Science & Disease Prevention Taskforce (<https://www.bps.org.uk/coronavirus-resources/coordinating-group/behavioural-science>) and Independent Scientific Pandemic Influenza Group on Behaviours known as SPI-B (<https://www.gov.uk/government/groups/independent-scientific-pandemic-influenza-group-on-behaviours-spi-b>). Behavioural scientists can help to identify the relevant target behaviours (Michie et al., 2020a) and their determinants (Gibson Miller et al., 2020) and give a full appraisal of the relevance of intervention and policy options (Michie et al., 2020b), sometimes before large scale changes are implemented.

Returning to the research question once again, whilst there is some learning from behavioural insights for health psychology there is clearly also learning the other way around. A more transdisciplinary approach to behaviour science would be beneficial (McManus, Constable, Bunten & Chadborn, 2018). The surprising lack of cross-fertilisation between traditional economists, behavioural economists and psychologists has also been noted before (Hanoch & Finkelstein, 2013).

### 5.3 Practical implications

The inclusion of the COM-B model and its links to the TDF in the BCW is an attempt to make it easier to select and apply theory to intervention design largely for those working in policy or practice. However, the wide spread use of these tools by

researchers and health psychologists (see for example a review of the multiple uses of the TDF in Atkins et al., 2017) and continued popularity of BI frameworks in government suggests that HP frameworks still retain a level of complexity that is beyond most behaviour change practitioners in local and national government with efforts continuing to simplify the use of theory for non-expert behaviour change practitioners (e.g. Dixon & Johnston, 2020; West, 2019).

Interventions designed from a BI perspective however, are not so focused on theory and instead prioritise the use of robust testing to determine effectiveness through implementation in the specific context within which the intervention is intended to be applied (Haynes et al., 2012; OECD, 2017). Whilst an understanding of a specific behavioural concept, often drawn from dual process theory has inspired the approach, theory development and advancement is not a key tenet. This means that the multi-component interventions included in this thesis, lack of factorial designs (except in one instance) and the lack of resources for process evaluations (except in two instances) mean it is often not possible to determine why the interventions presented here worked or did not work and to be sure of the mechanisms through which this has occurred. Important as robust testing is in a policy context, also important is justifying the choice of insights to test through a thorough understanding of the behaviour being changed, especially if we are to understand the reasons for intervention effectiveness or ineffectiveness and to recommend intervention applicability for scaling up to other local areas or contexts. Articulating programme theory in intervention development is recommended in the updated MRC framework for complex intervention design (O’Cathain et al., 2019).

It seems that with a shared aim of optimising the use of psychology in government policy interventions, there is a need to improve: (i) the accessibility of health psychology frameworks and (ii) the scientific application of behavioural insights frameworks to enable identification of evidence-based techniques to change influences on behaviour after a thorough analysis of the appropriate target behaviour. That is not to say there is no place for opportunistic, rapid pragmatic trials in the absence of time and evidence, but that alongside this there needs to be a

more strategic applied behavioural science approach occurring together in government and academia.

More specifically, based on the analysis in this thesis, it is recommended that:

(i) the behavioural insights literature needs to be more structured in terms of identifying which of its concepts are influences on behaviours and which are techniques for changing behaviour. A prospective tool including parameters or guidance to enable intervention developers to apply it would allow the novel techniques to be applied in a transparent way in the absence of evidence of other effective techniques. The BCT- T V1 includes both effective and potentially ineffective techniques. A new BI taxonomy including techniques that have not yet been applied, albeit with good guidance on how they should be applied given an understanding of the mechanism of action they are trying to change, is not too distant a step from the existing landscape.

(ii) health psychology frameworks should explicitly consider whether there is any place for concepts from behavioural insights in existing frameworks. This should involve specifically seeking or developing BCTs targeting automatic influences on behaviour. As well as exploring the BI literature and its social psychology and behavioural economics origins, the Intervention Mapping approach (Kok et al., 2016) also offers a range of BCTs which are linked by evidence to their determinants and explicitly include nudging, automatic, habitual and impulsive behaviours as well as environmental factors and should be considered alongside other taxonomies attempting to classify nudge type techniques (Hollands et al, 2017; Johnson et al., 2012; Munscher, Vetter & Scheurle, 2016).

There is an availability of public policy and behavioural economics/insights literature to retrospectively code for techniques applied to policy interventions and there may be value in doing this. However, what is really needed at this stage is a simple tool to enable local and national policy-makers to utilise the existing psychological and economic literature to prospectively design behaviour change interventions in policy

with transparency and robust justification for selected techniques and insights applied.

#### 5.4 Concluding remarks

The success of the trials presented in this thesis provide compelling evidence for government policy makers to engage in rigorous testing, evaluation and close monitoring of policies aimed at behaviour change. The behavioural insights movement in government has brought behavioural science into profile. But to retain credibility, the scientific method needs to advance and become more strategic. BI trials need to be integrated into workstreams involving strategic behavioural analyses of full policy areas and analysis of existing interventions.

In summary the trials presented in this thesis demonstrate good value (low resource, high impact) but going forward a more integrated behavioural science approach to behavioural interventions in policy which is strategically aligned with policy goals could maximise the impact of a transdisciplinary approach to the application of behavioural science in a policy context.

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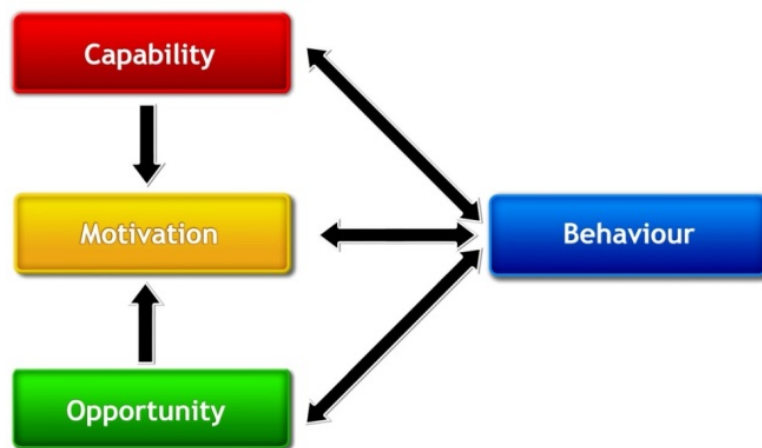
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## Appendix A: Health psychology frameworks

Figure 12: COM-B model (Michie et al., 2011)



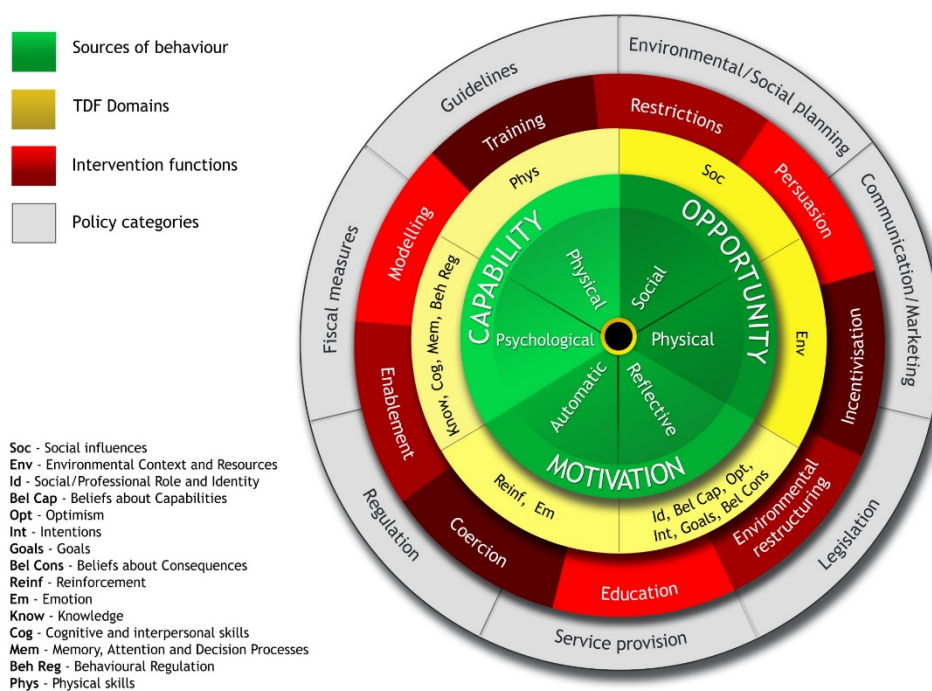
The COM-B model is a system of interacting components whereby the following six conditions must be met for a behaviour to be enacted:

- Physical capability: The individual must have the physical ability to perform the behaviour (e.g. manual dexterity to turn on a tap and wash one's hands).
- Psychological capability: The individual must have the knowledge, psychological skills, mental strength and stamina to perform the behaviour (e.g. know how and when to wash hands and remember to do it).
- Reflective motivation: The individual must believe that the behaviour is a good thing to do and that the benefits outweigh the harms (e.g. believe that washing hands will reduce infection risk).
- Automatic motivation: the individual must want or need to perform the behaviour over competing behaviours and desires and experience supportive emotions as well as developing habits for the behaviour (e.g. is in the habit of washing hands after using a toilet and feels disgust at not doing so).

- Physical opportunity: the individual must have the physical or material resources to perform the behaviour including the time to perform it (e.g. A tap and some water must be available to wash hands).
- Social opportunity: the behaviour should be considered socially acceptable (e.g. the individual should feel that most people wash hands after using the toilet).

Motivation for the target behaviour must be greater than for competing behaviours for the behaviour to be performed (Michie et al., 2011).

**Figure 13: Behaviour Change Wheel (with TDF domains) (Atkins et al., 2017)**



The COM-B model is linked to the TDF (in yellow in figure 13) which provides more detailed domains within each of these. The COM-B domains are linked to intervention functions (see table 11) which can facilitate delivery of change through that mechanism. For example, if the analysis of the target behaviour using COM-B (known as a COM-B or behavioural diagnosis) shows a knowledge deficit to be the

problem this would fall into psychological capability which is linked to the intervention function 'education'. It is not linked to persuasion for example as you cannot persuade people that they know something they do not. The policy categories are then linked to the intervention functions to indicate which are best suited for delivery of the intervention. In the present example an educational intervention might be delivered through communication and marketing but would not be delivered through legislation.

**Table 11: Definitions of intervention types (Michie et al., 2014)**

The COM-B model is linked to nine intervention types or functions which can be used to deliver change (see the red ring in figure 13).

<i>Education</i>	Increasing knowledge and understanding by informing, explaining, showing and providing feedback
<i>Persuasion</i>	Using words and images to change the way people feel about a behaviour to make it more or less attractive
<i>Incentivisation</i>	Changing the attractiveness of a behaviour by creating the expectation of a desired outcome or avoidance of an undesired one
<i>Coercion</i>	Changing the attractiveness of a behaviour by creating the expectation of an undesired outcome or denial of a desired one
<i>Training</i>	Increasing the skills needed for a behaviour by repeated practice and feedback
<i>Restriction</i>	Constraining performance of a behaviour by setting rules
<i>Environmental restructuring</i>	Constraining or promoting behaviour by shaping the physical or social environment
<i>Modelling</i>	Showing examples of the behaviour for people to imitate
<i>Enablement</i>	Providing support to improve ability to change in a variety of ways not covered by other intervention types

Certain intervention types are suitable for delivering change through certain COM-B domains. Table 12 demonstrates which COM-B influence on behaviour is best suited to which intervention type.



**Table 12: Links between COM-B and Intervention Functions (Michie et al., 2014)**

	Education	Persuasion	Incentivisation	Coercion	Training	Restriction	Environmental restructuring	Modelling	Enablement
Physical Capability									
Psychological Capability									
Physical Opportunity									
Social Opportunity									
Automatic Motivation									
Reflective Motivation									



Figure 14: BCT Taxonomy Version 1 (Cane et al., 2012)

BCT Taxonomy (v1): 93 hierarchically-clustered techniques

Page	Grouping and BCTs	Page	Grouping and BCTs	Page	Grouping and BCTs
<b>1</b>	<b>1. Goals and planning</b>	<b>8</b>	<b>6. Comparison of behaviour</b>	<b>16</b>	<b>12. Antecedents</b>
	1.1. Goal setting (behavior) 1.2. Problem solving 1.3. Goal setting (outcome) 1.4. Action planning 1.5. Review behavior goal(s) 1.6. Discrepancy between current behavior and goal 1.7. Review outcome goal(s) 1.8. Behavioral contract 1.9. Commitment		6.1. Demonstration of the behavior 6.2. Social comparison 6.3. Information about others' approval		12.1. Restructuring the physical environment 12.2. Restructuring the social environment 12.3. Avoidance/reducing exposure to cues for the behavior 12.4. Distraction 12.5. Adding objects to the environment 12.6. Body changes
		<b>9</b>	<b>7. Associations</b>		
			7.1. Prompts/cues 7.2. Cue signalling reward 7.3. Reduce prompts/cues 7.4. Remove access to the reward 7.5. Remove aversive stimulus 7.6. Satiation 7.7. Exposure 7.8. Associative learning	<b>17</b>	<b>13. Identity</b>
<b>3</b>	<b>2. Feedback and monitoring</b>				13.1. Identification of self as role model 13.2. Framing/reframing 13.3. Incompatible beliefs 13.4. Valued self-identify 13.5. Identity associated with changed behavior
	2.1. Monitoring of behavior by others without feedback 2.2. Feedback on behaviour 2.3. Self-monitoring of behaviour 2.4. Self-monitoring of outcome(s) of behaviour 2.5. Monitoring of outcome(s) of behavior without feedback 2.6. Biofeedback 2.7. Feedback on outcome(s) of behavior	<b>10</b>	<b>8. Repetition and substitution</b>	<b>18</b>	<b>14. Scheduled consequences</b>
			8.1. Behavioral practice/rehearsal 8.2. Behavior substitution 8.3. Habit formation 8.4. Habit reversal 8.5. Overcorrection 8.6. Generalisation of target behavior 8.7. Graded tasks		14.1. Behavior cost 14.2. Punishment 14.3. Remove reward 14.4. Reward approximation 14.5. Rewarding completion 14.6. Situation-specific reward 14.7. Reward incompatible behavior 14.8. Reward alternative behavior 14.9. Reduce reward frequency 14.10. Remove punishment
<b>5</b>	<b>3. Social support</b>			<b>19</b>	<b>15. Self-belief</b>
	3.1. Social support (unspecified) 3.2. Social support (practical) 3.3. Social support (emotional)	<b>11</b>	<b>9. Comparison of outcomes</b>		15.1. Verbal persuasion about capability 15.2. Mental rehearsal of successful performance 15.3. Focus on past success 15.4. Self-talk
			9.1. Credible source 9.2. Pros and cons 9.3. Comparative imagining of future outcomes	<b>19</b>	<b>16. Covert learning</b>
<b>6</b>	<b>4. Shaping knowledge</b>				16.1. Imaginary punishment 16.2. Imaginary reward 16.3. Vicarious consequences
	4.1. Instruction on how to perform the behavior 4.2. Information about Antecedents 4.3. Re-attribution 4.4. Behavioral experiments	<b>12</b>	<b>10. Reward and threat</b>		
<b>7</b>	<b>5. Natural consequences</b>		10.1. Material incentive (behavior) 10.2. Material reward (behavior) 10.3. Non-specific reward 10.4. Social reward 10.5. Social incentive 10.6. Non-specific incentive 10.7. Self-incentive 10.8. Incentive (outcome) 10.9. Self-reward 10.10. Reward (outcome) 10.11. Future punishment		
	5.1. Information about health consequences 5.2. Salience of consequences 5.3. Information about social and environmental consequences 5.4. Monitoring of emotional consequences 5.5. Anticipated regret 5.6. Information about emotional consequences	<b>15</b>	<b>11. Regulation</b>		
			11.1. Pharmacological support 11.2. Reduce negative emotions 11.3. Conserving mental resources 11.4. Paradoxical instructions		

i

Definitions of the BCTs can be found in Michie et al., (2014).

## Appendix B: Behavioural insights frameworks

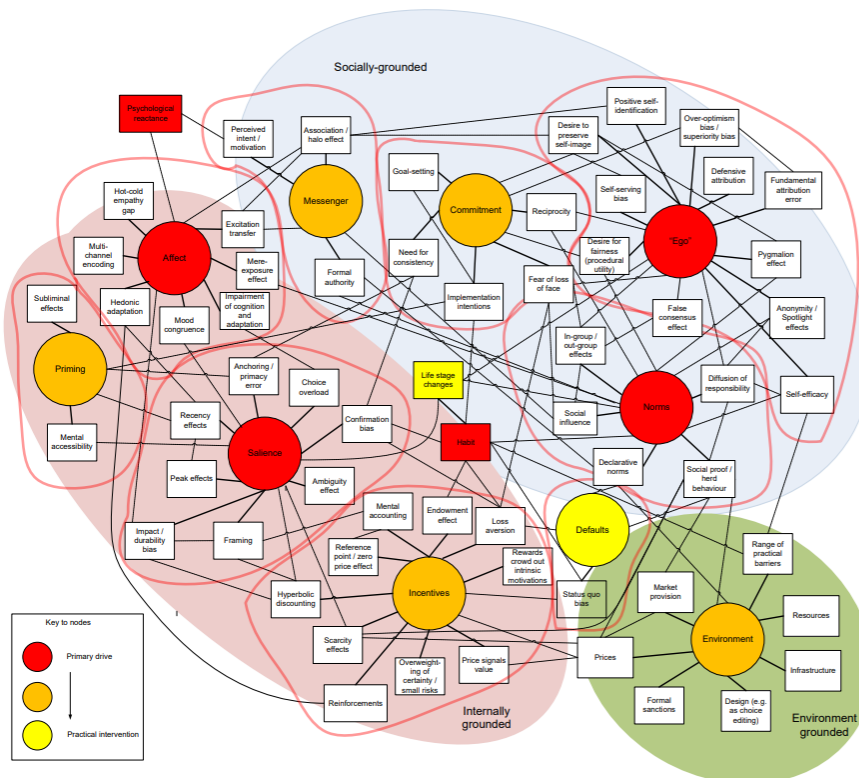
Table 13 shows definitions of the main constructs in MINDSPACE (Dolan et al., 2010, p. 8)

**Table 13: MINDSPACE definitions**

<b>Messenger</b> we are heavily influenced by who communicates information
<b>Incentives</b> our responses to incentives are shaped by predictable mental shortcuts such as strongly avoiding losses
<b>Norms</b> we are strongly influenced by what others do
<b>Defaults</b> we "go with the flow" of pre-set options
<b>Salience</b> our attention is drawn to what is novel and seems relevant to us
<b>Priming</b> our acts are often influenced by sub-conscious cues
<b>Affect</b> our emotional associations can powerfully shape our actions
<b>Commitments</b> we seek to be consistent with our public promises and reciprocate acts.
<b>Ego</b> we act in ways that make us feel better about ourselves

The MINDSPACE map (figure 15) was used to identify constructs behind the main definitions.

**Figure 15: Mindspace mapped (Dolan et al., p. 80)**



#### Annex 1: MINDSPACE mapped

Diagram presenting the concepts related to the elements in MINDSPACE. The solid lines indicate that a given psychological process is considered as being an essential part (as a direct consequence, cause or manifestation) of the principle in question (e.g. framing is making something salient, while salience causes recency effects). The dotted lines are secondary connections, while the red/orange/yellow colouring of the circles denotes whether the factor is a primary drive (e.g. affect) or whether it is more applied (e.g. defaults). The red grouping lines denote the boundaries of MINDSPACE.

More details on the terms in the diagram can be found in:

Hewstone, Stroebe, Jonas (2007) *Introduction to Social Psychology: A European Perspective*. Chichester: Wiley, Fourth Edition.

**Table 14: MINDSPACE concepts derived from MINDSPACE map**

<b>Domain</b>	<b>Sub-domain</b>
Messenger	Messenger
Messenger	Association / Halo effect
Messenger	Perceived intent/motivation
Messenger	Formal authority
Incentives	Incentives
Incentives	Endowment effect
Incentives	Loss aversion
Incentives	Rewards crowd out intrinsic motivation
Incentives	Price signals value
Incentives	Overweighting of certainty / small risks
Incentives	Reinforcements
Incentives	Scarcity effects
Incentives	Hyperbolic discounting
Incentives	Reference point / zero price effect
Incentives	Mental Accounting
Norms	Norms
Norms	Diffusion of responsibility
Norms	Social proof / Herd Behaviour
Norms	Declarative norms
Norms	Social influence
Norms	In-group / Out-group effects
Norms	Fear of loss of face
Habit*	Habit
Defaults	Defaults
Defaults	Status quo bias
Salience	Anchoring / Primacy error
Salience	Choice overload
Salience	Confirmation bias
Salience	Ambiguity effect
Salience	Framing

Salience	Impact / Durability bias
Salience	Peak effects
Salience	Recency effects
Priming	Priming
Priming	Subliminal effects
Priming	Mental accessibility
Affect	Affect
Affect	Hot-cold empathy gap
Affect	Excitation transfer
Affect	Mere-exposure effect
Affect	Impairment of cognition and adaptation
Affect	Mood congruence
Affect	Hedonic adaptation
Affect	Multi-channel encoding
Affect	Psychological reactance
Commitments	Commitments
Commitments	Reciprocity
Commitments	Fear of loss of face
Commitments	Implementation intentions
Commitments	Need for consistency
Commitments	Goal setting
Ego	Positive self-identification
Ego	Over optimism bias / superiority bias
Ego	Defensive attribution
Ego	Fundamental attribution error
Ego	Pygmalion effect
Ego	Anonymity / Spotlight effect
Ego	Self-efficacy
Ego	False consensus effect
Ego	Desire for fairness (procedural utility)
Ego	Self-serving bias
Ego	False consensus effect
Ego	Desire to preserve self-image

Environment*	Range of practical barriers
Environment	Resources
Environment	Infrastructure
Environment	Design (e.g. as choice editing)
Environment	Formal sanctions
Environment	Prices
Environment	Market provision

\*Not in MINDSPACE acronym but in 'MINDSPACE mapped'

**Table 15: EAST definitions <sup>7</sup>**

Easy	Defaults	We tend to 'go with the flow' of a pre-set option
Easy	Friction Costs	We can be deterred from taking an action by seemingly small barriers (like filling in a form) We are more likely to take action when it's easy for us to do so (and clear what is being asked of us)
Easy	Simplification	
Easy	Goal Setting	We are more likely to achieve objectives if we are given a specific goal.
Easy	Chunking	We find it easier to achieve complex goals if they are broken up into sub goals. The positioning of a piece of information, i.e. what comes before or after it, influences how it is perceived
Easy	Ordering Effects	
Easy	Substitution	It is easier for us to substitute a similar behaviour than to eliminate an entrenched one.
Easy	Checklists	Checklists help us remember important steps in a process, particularly in stressful situations.
Attractive	Salience	Our attention is drawn to what is novel and seems relevant to us.
Attractive	Loss Aversion	We dislike losses more than we like gains of an equivalent amount Lotteries are effective because we tend to overweight the likelihood of rare events, and focus more on the prize than the probability
Attractive	Lotteries	

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<sup>7</sup> Copied from training cards by Behavioural Insights Ltd available from <https://www.bi.team/our-work/tools/buy-east-cards/>

		We think of money as being allocated for different categories rather than as being interchangeable across categories
Attractive	Mental Accounting	
Attractive	Personalise	We are more likely to respond to messages or services which are tailored to us
Attractive	Scarcity	We are more attracted to goods if we believe the supply is limited.
Attractive	Framing Effect	We react differently to the same information, depending on how it is framed.
Attractive	Endowment Effect	We tend to value objects we already own more than equivalent objects we do not yet own.
Social	Descriptive Norm	We use other people's behaviour as a cue for what's acceptable and desirable.
Social	Reciprocity	We have an inherent desire to help those who have helped us in some way
Social	Network Nudge	We are influenced by the behaviour of friends or friends of friends
		We are influenced by how our performance compares with others', especially those with similar characteristics to ourselves.
Social	Relative Ranking	When we actively commit to achieving a goal, we are more likely to achieve it, especially if the
Social	Commitment Contracts	commitment is paired with a penalty for failure
Social	Messenger Effects	We are heavily influenced by the communicator of information.
		Public services can be delivered more efficiently and effectively by encouraging citizens to support
Social	People Helping People	one another
		We are more likely to achieve a goal if provided with timely, structured feedback on how we are
Social	Feedback	performing in relation to that goal
Timely	Present Bias	We disproportionately prefer rewards that come sooner and costs that are borne later



Timely	Implementation Intention Foot-in-the-Door	We are more likely to do something when we specify how, when and where we will do it.
Timely	Technique	If we comply with an initial small request, we are more likely to comply with a later, larger request
Timely	Prompts	We are more likely to undertake an activity if given a prompt at the right moment
Timely	Head Start	A head start can help us achieve our goals by making it feel like we are making progress.
Timely	Deadlines	We are more likely to achieve goals if we have a clear deadline
Timely	Anchoring	Exposure to a number influences subsequent judgements
Timely	Priming	Our actions can be influenced by subconscious cues

## Appendix C: Intervention coding

Characterisation of the COM-B influences that were targeted by interventions was carried out in accordance with the COM-B descriptions provided in Appendix A, figure 12. The COM-B domain targeted describes the intended mechanism of action (known since I was the intervention developer) although it is not possible to know if the intervention techniques delivered changed behaviour through these mechanisms as this was not researched.

BCTs were coded according to the published data in each paper where available. If BCTs were not reported in published papers they were coded according to my detailed knowledge of the interventions and their intended BCTs.

Intervention Functions were coded according to what was delivered in the intervention, with only those Intervention Functions that aligned with the coded COM-B components being considered for inclusion (i.e. in accordance with the matrix described in Appendix A, Table 12).

Policy categories were not coded due to word count and as only two are relevant (communication/marketing and environmental/social planning) due to the focus of the thesis being on message design.

MINDSPACE concepts were coded where they were seen to be relevant to the intervention design (i.e. the techniques used to deliver the intervention or an influence on behaviour which the intervention aimed to target). MINDSPACE was coded independently from the other frameworks.

EAST was coded only where its constructs added detail beyond the MINDSPACE concepts.

Links between the influences on behaviour and techniques used to change the behaviour are not considered in the thesis coding due to (i) a lack of tools to do this for the BI frameworks and (ii) the developing nature of the field - there are now

multiple potential sources which could be used however there are gaps and discrepancies within and between them. For example, the MAP mechanisms of action (Dixon & Johnston, 2020) are not linked to COM-B and the TDF- BCT coding (Cane et al., 2015) does link back to COM-B through the TDF domains but this is superseded by the TaTT (Johnston et al., 2020). Yet, the TaTT, which contains less BCTs and more mechanisms of action than the TDF (albeit with less detailed descriptions of their meaning) does not link the additional mechanisms of action to COM-B.

Outside the narrative of a PhD by Published Works it would be usual to have some form of inter-rater reliability testing and dual coding for the interventions and this should be noted as a limitation where this occurred beyond extraction from the published papers. In the absence of dual coding it is useful to reflect on some of the wider influences on my coding in particular for COM-B. For example, automatic motivation may have been coded more often than in a pure health psychology approach, since the MINDSPACE concepts are all believed to influence behaviour through automatic processes (Vlaev et al., 2015). Therefore, although the coding does not explicitly follow any of the influence-technique mapping tools mentioned, knowledge of the mapping tools and frameworks may have played a part in coding the COM-B influences on behaviour especially where MINDSPACE concepts are considered dominant in the intervention design and/or where few BCTs were identified as relevant. It should also be noted that although I am a trained BCT coder, some BCTs have lower coding reliability (Abraham et al., 2015).

## Appendix D: Template for Intervention Description and Replication (TIDieR) checklist

Table 16: TIDieR descriptions (Hoffmann et al., 2014)

TIDIER checklist												
Study	Name. Name that describes intervention	Why? Describe any rationale, theory or goal of the elements essential to the intervention.	What? Materials used	What? Procedures used	Who? Person who delivered the intervention	How? How the intervention was delivery (e.g. face-to face)	Where? The immediate setting of the intervention Describe the type(s) of location(s) where the intervention occurred.	When and how much?	Tailoring? Describe any personally tailored features of the intervention	Modification s Describe any change to the intervention during the trial	Planned implementat ion fidelity? Who assessed the interventions implementati on fidelity and how	Actual implementat ion fidelity? Was the intervention implemented as planned?
Study 1	Organ donation messaging	Increase registrations to the organ donation register (ODR)	8 variants of short persuasive message inviting sign ups to the ODR. Available in the published paper.	Text on the webpage after the road tax transaction inviting individuals to join the ODR and providing a button to click to do so. The intervention message is presented alongside this invitation. Individuals can click to join, click to find out more or close down the page/computer	Government Digital Service (GDS) online platform and National Health Service Blood and Transplant (NHSBT).	Website	The GOV.UK webpage after completing road tax transactions.	The message appeared once at the end of road tax transactions over a 4-week period (24th June 2013 - 19 July 2013).	None	None	GDS and NHSBT checked the webpages were live and working.	Yes

Study 2	Screening and brief alcohol intervention.	Increase completions of the alcohol screening tool and engagement with online interventions.	Text on the Drinkaware homepage inviting people to complete a screening tool. Once complete they see a web page with frame-congruent (health v appearance) information according to their drinking risk level and are invited to engage with further resources. Available in the supplementary files of the published paper.	Visitors to the website were exposed to appearance or health framed messages directing them towards an AUDIT-C risk screening questionnaire. Upon completion feedback on risk level and extended frame-congruent information was provided.	Drinkaware Trust website	Website	Drinkaware home page	The home page was randomised for visitors to the website during a 6-week period during November – December 2014.	Extended frame congruent information was based upon risk level (low or increasing risk) determined by completion of the screening tool.	None	The Drinkaware and PHE teams checked the interventions were live and working.	Yes
Study 3	Behaviourally informed letter to parents of overweight children.	Increase uptake of family weight management services.	A letter with MapMe Body Image Scales, a social norms statement and invitation to weight management services. Those measured as very overweight received a pre-populated	Letters were sent to parents of children who were measured as overweight or very overweight at school as part of the National Child Measurement Programme (NCMP) inviting	Letters were sent and signed from Local Authority public health departments.	Letter.	Schools in 3 English counties participating in NCMP.	Letters were sent within 6 weeks of school nurses collecting weight and height measurements between 5th January and 29th May 2015.	Parents of very overweight children received a personalised booking form as well as a written invitation to weight management services as per parents of overweight children.	None	None	N/A

			(personalised) weight management service booking form. Available in the supplementary files of the published paper.	attendance at weight management services (as well as informing them of their child's weight status). A social norms message is provided and Body Image Scales depicting the appearance of children of differing weights.								
Study 4	Behaviourally informed letter to increase uptake of NHS Health Checks.	Increase uptake of NHS Health Checks (NHS HC)	A letter inviting patients to attend an NHS Health Check. Available in the supplementary files of the published paper.	Letters were sent to those due to attend an NHS HC. Attendance was recorded.	Letters were sent and signed by practices.	Letter	General Practices in Medway, England.	Letters were sent to all patients eligible for an NHS HC in May and June 2013.	None	None	None	N/A
Study 5	Behaviourally informed letter and SMS primers and reminders to increase uptake of NHS Health Checks.	Increase uptake of NHS Health Checks	A letter inviting patients to attend an NHS Health Check. SMS primer and reminders. Available in the supplementary files of the	Letters were sent to those due to attend an NHS HC. Attendance was recorded. SMS primers and reminders were also sent to some groups.	Letters were sent and signed by practices.	Letter and SMS	General Practices in the London Borough of Southwark, England.	Letters and SMS were sent to all patients at 28 General Practices in the London Borough of Southwark who were eligible to receive an NHS HC between 1st	None	None	None	N/A

			published paper.					November 2013 and 31st December 2014. Batches of letters and SMS were sent out monthly. Patients allocated to receive a primer SMS received this 1 week prior to their appointment letters. Patients in the reminder group received these 1 week after receiving the letter. A standard reminder letter was sent 12 weeks after the initial invitation letter to all patients.				
Study 6	Variation in content of outpatient appointment reminder SMS.	Reduce did not attend (missed hospital appointments )	SMS message content. Available in the published paper.	SMS messages were sent to patients 5 days prior to their hospital outpatient appointment. Did not attend rates	SMS were sent by IPlato – a media company contracted to send patient reminders texts.	SMS	Barts Hospital, London.	Outpatients with a valid mobile telephone number and an outpatient appointment between November 2013 and	None	None	None	N/A

				were recorded.				January 2014 (Trial One) or March - May 2014 (Trial Two) were sent SMS reminders 5days in advance of their appointment.				
Study 7	Social norms letter to high antibiotic prescribers in general practice.	Reduce antibiotic prescribing	A letter from England's Chief Medical Officer (CMO) informing practices that they are in the top 20% of antibiotic prescribers for their region. A Treat Your Own Infection Leaflet was included. Plus, patient marketing materials. Available in the published paper.	The top 20% of antibiotic prescribers in each NHS Local Area Team were informed of their high prescribing status through a letter from the CMO which also detailed actions they can take to help reduce prescribing. Prescribing rates were extracted from a national database.	The letter was from the CMO.	Letter	Nationally in England.	On Sept 29, 2014, every GP in the feedback intervention group was sent a letter and a leaflet on antibiotics for use with patients. GPs in the control group received no communication. The sample was re-randomised into two groups, and in December, 2014, GP practices were either sent patient-focused marketing information that promoted reduced use of antibiotics or received	None	None	None	N/A



								no communicati on				
Study 8	Prescriber commitment posters and antimicrobial stewardship messages to patients booking appointments .	Reduce antibiotic prescribing	A prescriber commitment poster and an antimicrobial stewardship telephone message to patients. Available in the supplementary files of the published paper.	Prescribers were asked to sign an antimicrobial stewardship commitment poster and provide a photograph of themselves. The personalised commitment poster was displayed in patient consulting rooms. An antimicrobial stewardship answerphone message was played to patients prior to accessing practice staff to book an appointment. Prescribing rates were extracted from a national database.	The prescriber commitment poster were organised by the research team at Public Health England (me) in collaboration with practice staff who also displayed the posters. The practice staff recorded and implemented the answerphone message to patients.	Poster and answerphone message.	209 practices from 29 clinical Commissioning Groups across England.	Interventions were in place between 1 <sup>st</sup> February 2016 and 30 <sup>th</sup> July 2016.	Where prescribers shared a consulting room up to 2 prescribers shared a poster personalised with both their names and photographs.	None.	Intervention practices were contacted by post and asked to confirm receipt and display of posters approximately two months after the trial started. Implementation of the automated message was checked at the start and mid-point of the trial by phoning practices.	Responses to poster fidelity checks for the 889 participating GPs in the two trial arms showed that 15 (CP) and 12 (CP&AM) practice units did not respond to poster fidelity checks representing missing data for 119 and 87 prescribers respectively. Of the practice units responding a further 11 (CP) and 61 (CP&AM) prescribers were reportedly not displaying the posters.  All practices in the first per protocol analysis implemented the AM at the start of the trial (i.e.

												<p>excluding the 12 who dropped out immediately post-randomization. Midway through 7 practices had stopped the message (3 unknown cause; 1 technical issue; 2 immediate responsiveness at reception interrupting the phone message; 1 building work at the clinic) with 5 reinstating the message when requested. The two practices not reinstating were excluded for the second per protocol analysis.</p>
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## **Appendix E: Copies of publications included in the thesis**